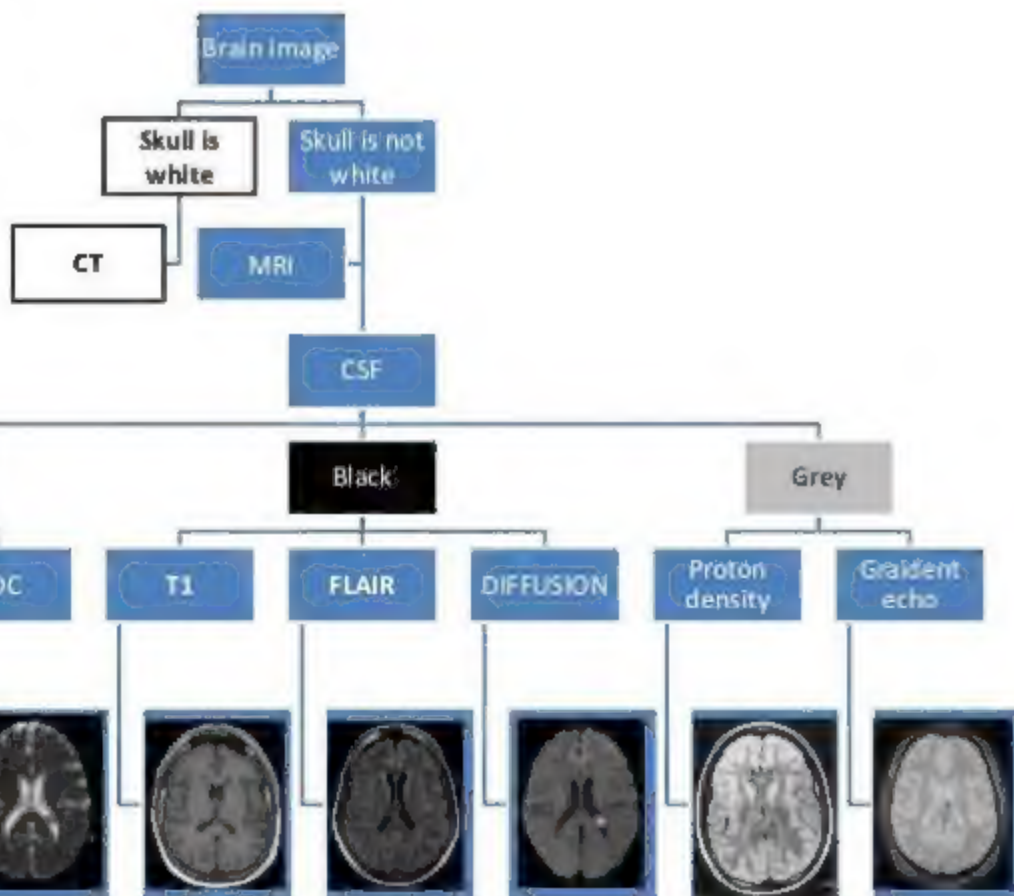
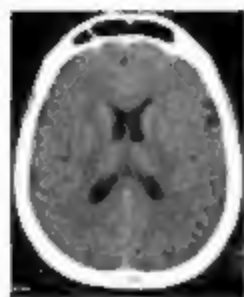
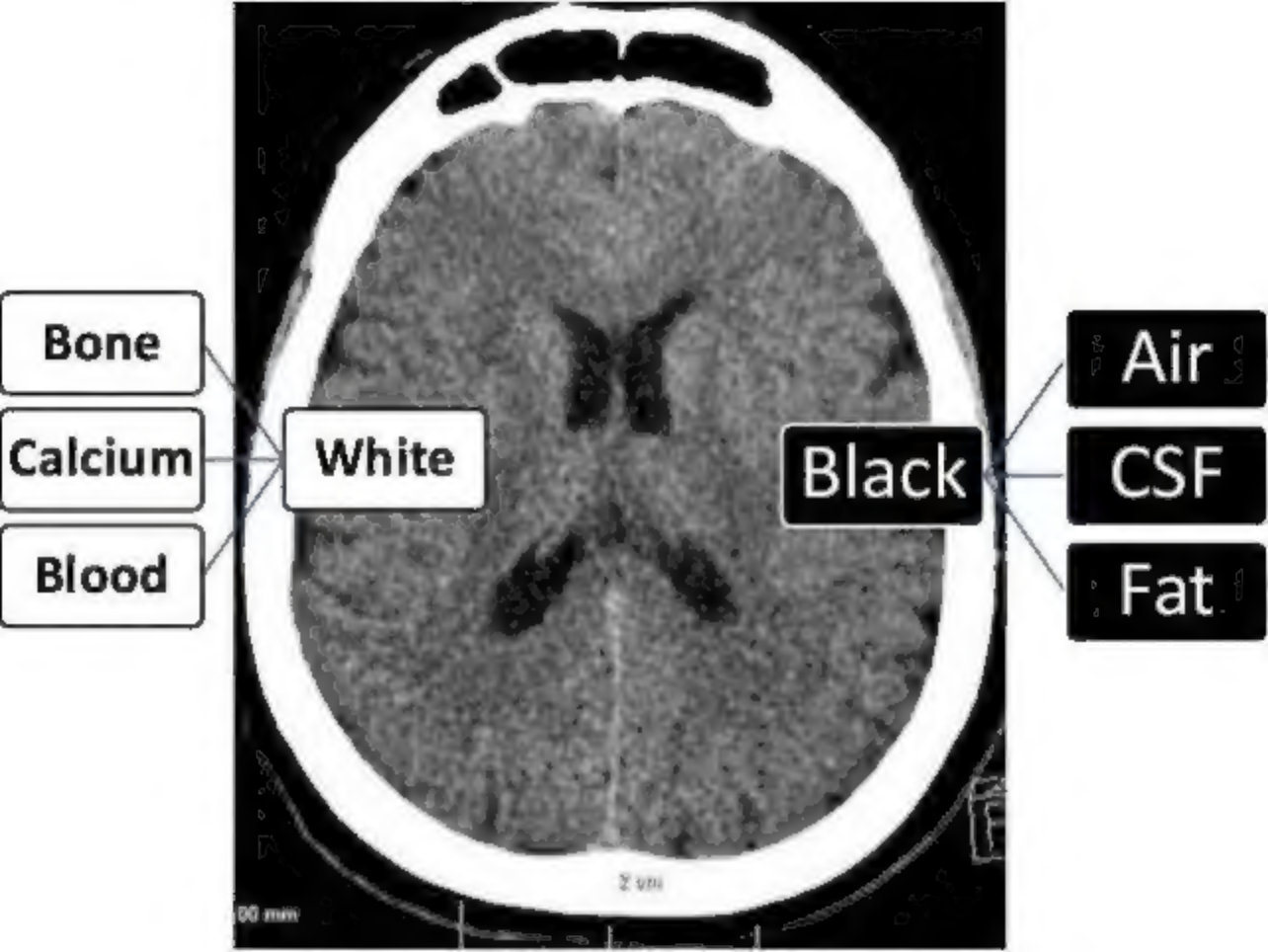
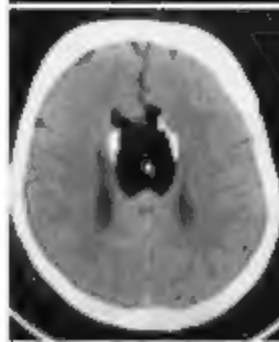
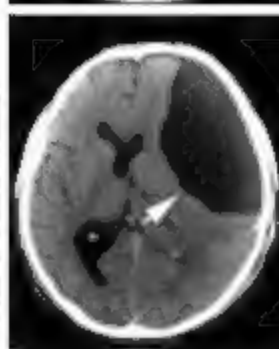
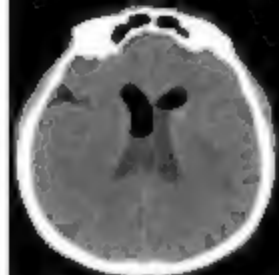
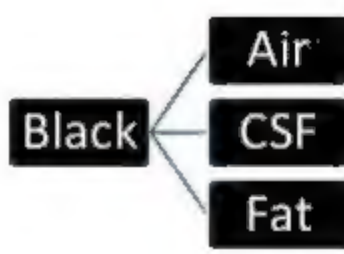
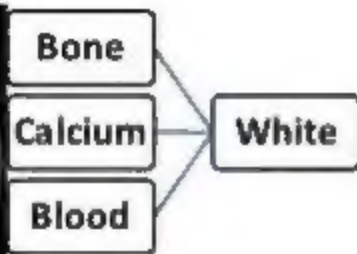
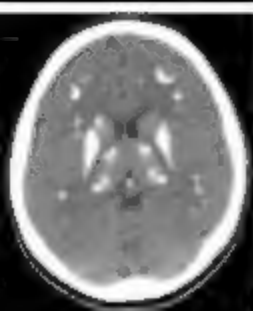


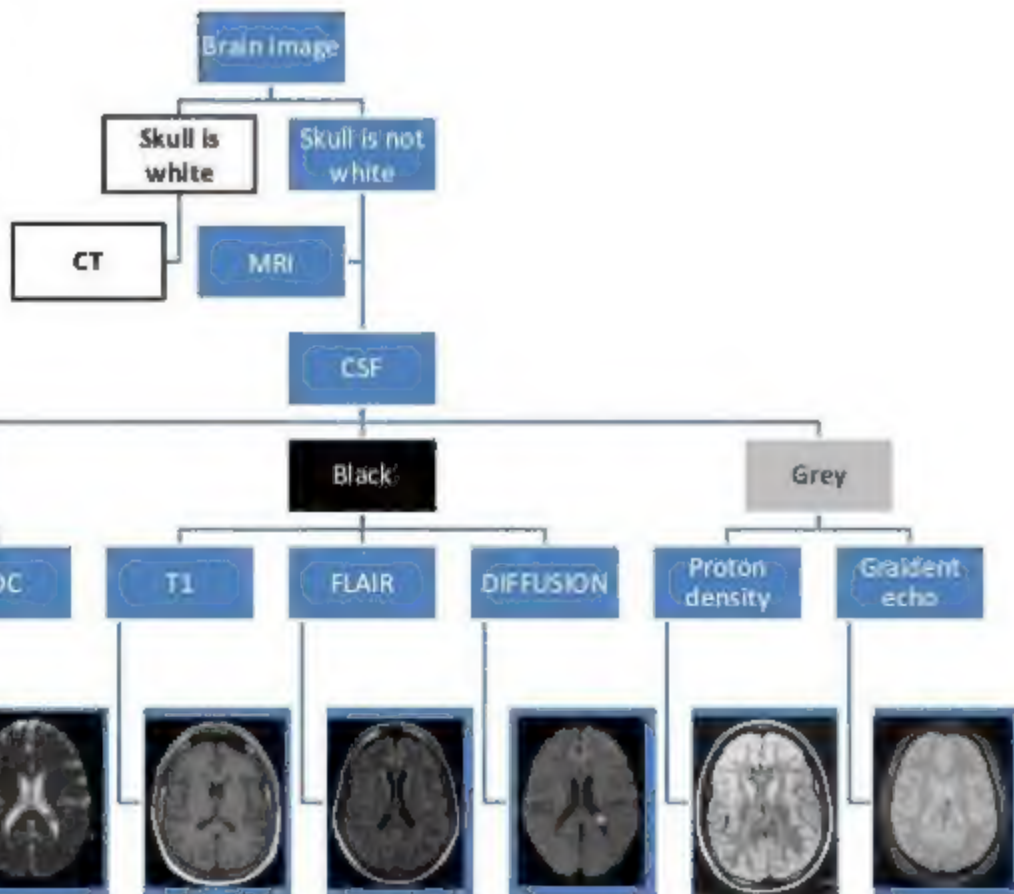
**What Am I
Looking At?**

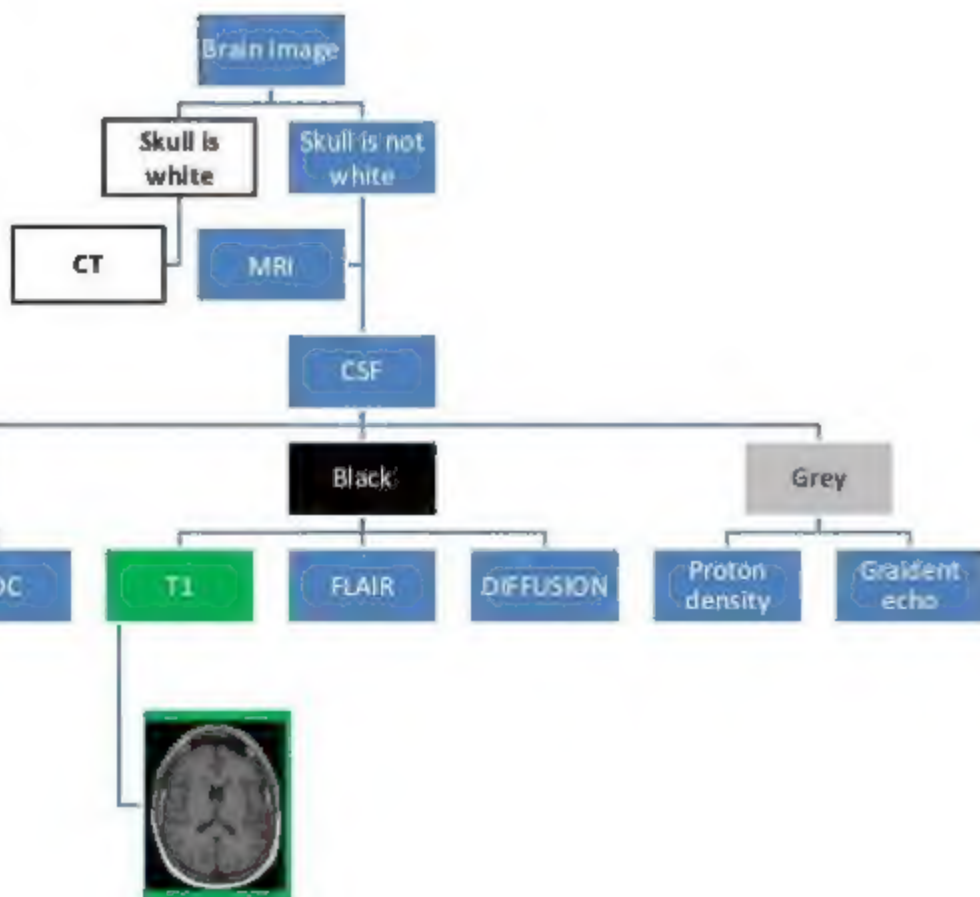
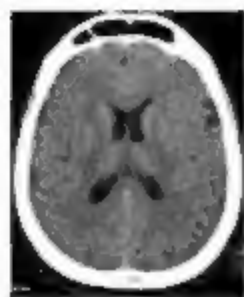












Bright signal on T1

Contrast

Gadolinium

Hemorrhage

Methemoglobin

Fat

Lipoma

Dermoid

Protein

Cysts of
endodermal
origin

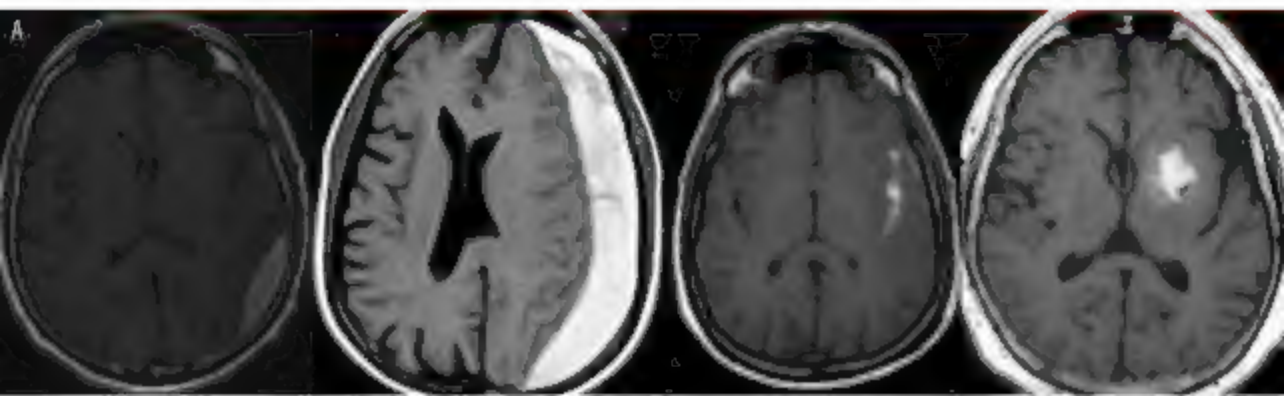
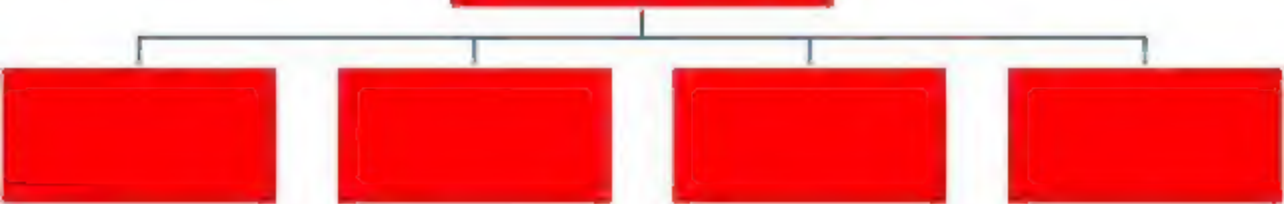
Minerals

Immature
calcification

Copper

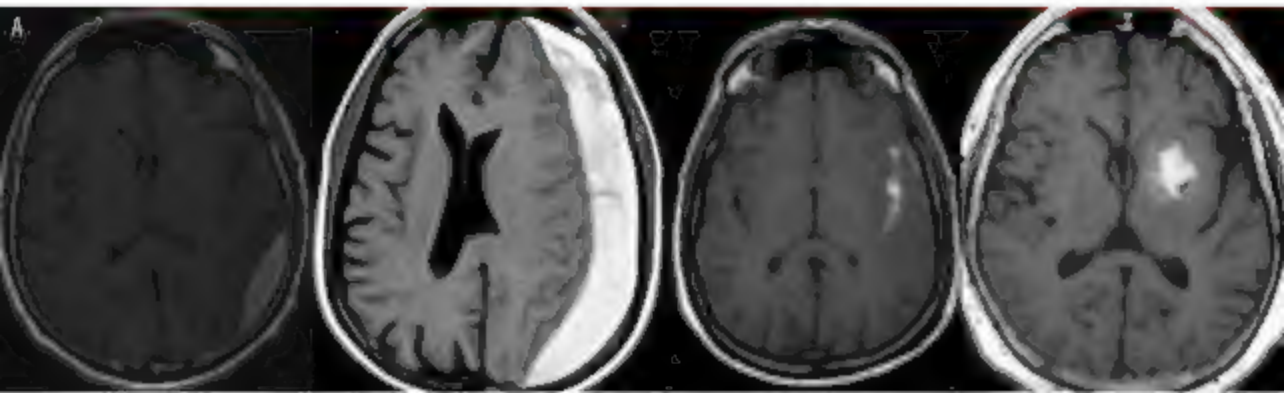
Manganese

Hemorrhage



Hemorrhage

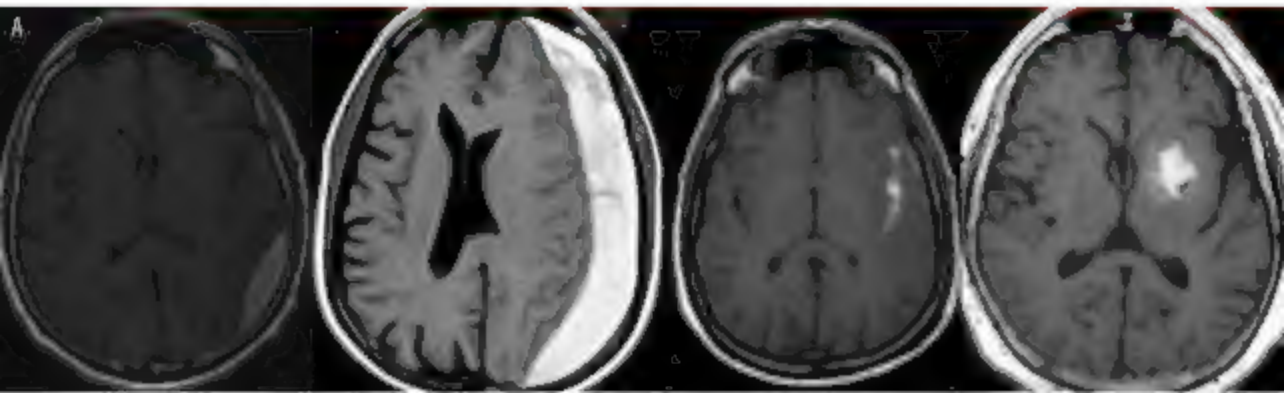
Epi-dural



Hemorrhage

Epi-dural

Sub-dural

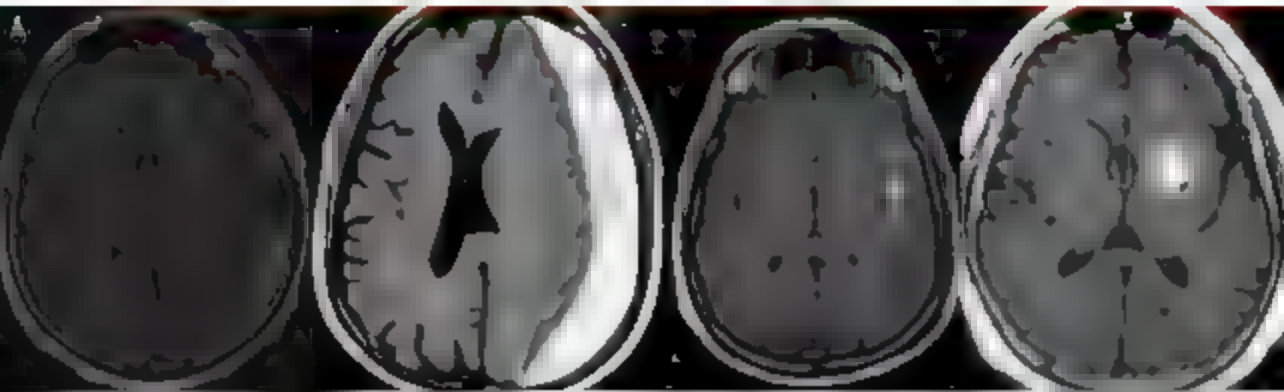


Hemorrhage

Epi-dural

Sub-dural

Sub
arachnoid



Hemorrhage

Epi-dural

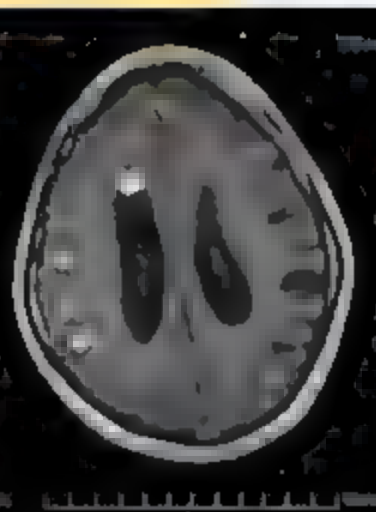
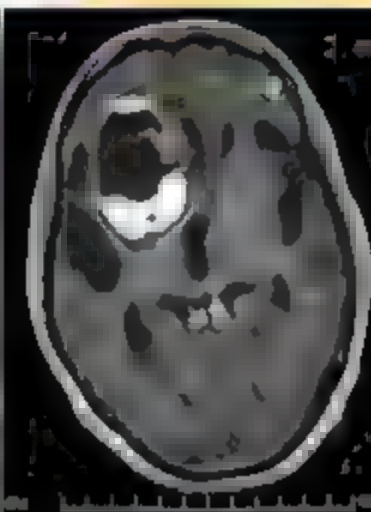
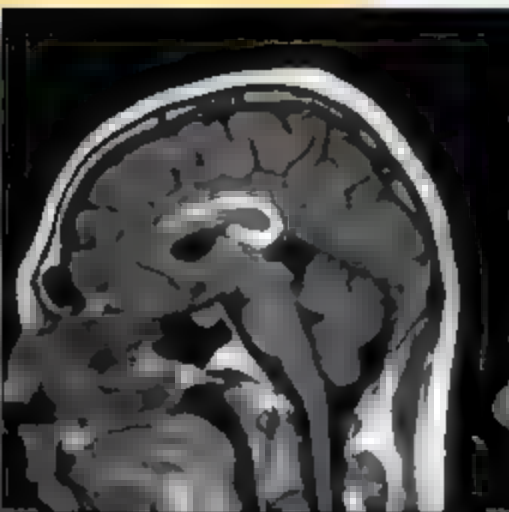
Sub-dural

Sub
arachnoid

Intra
cerebral



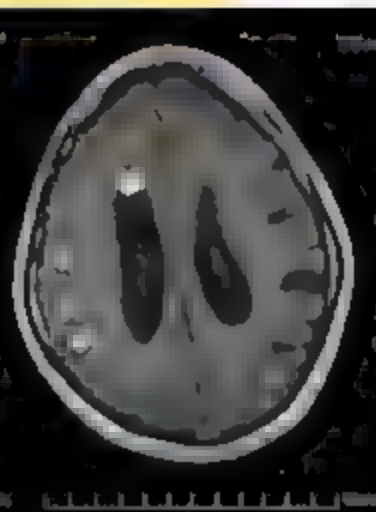
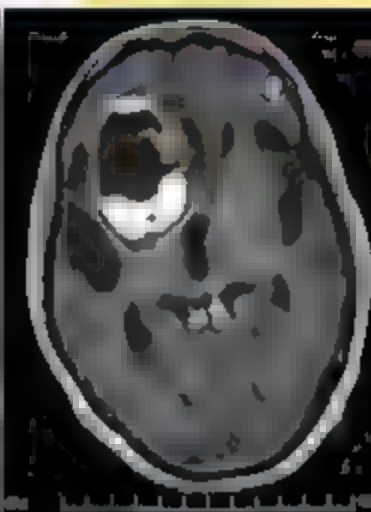
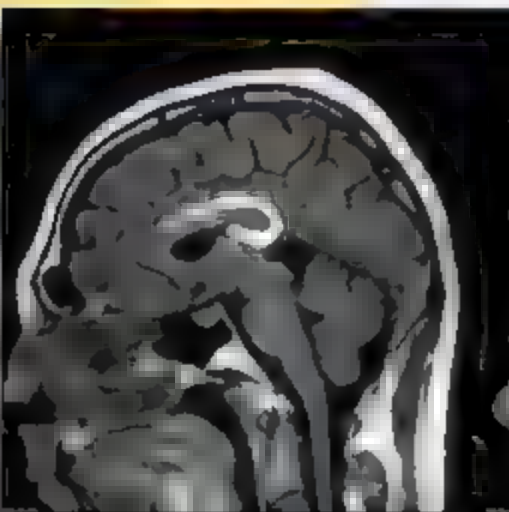
Path



Full

Negative

Unilateral

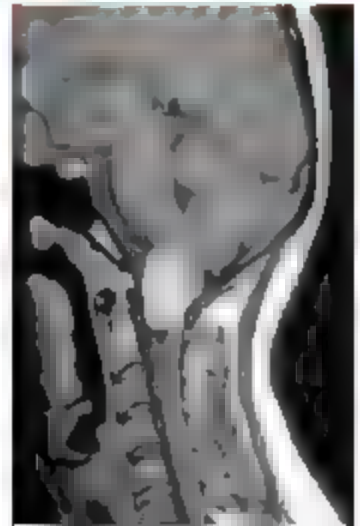
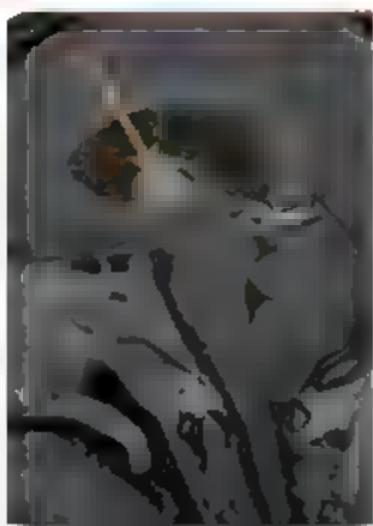


Spinal Cord Injury

Definition

Etiology

Diagnosis



Spinal Cord Injury

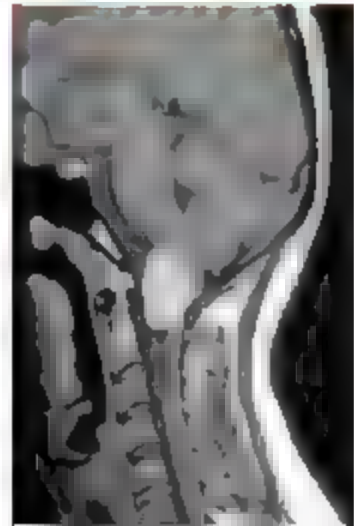
Pathophysiology

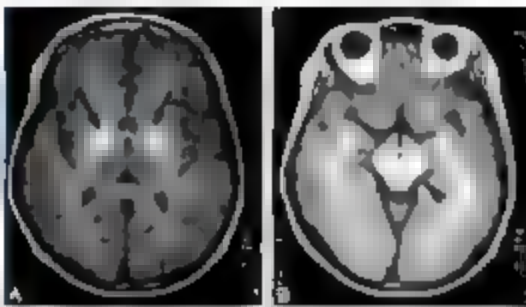
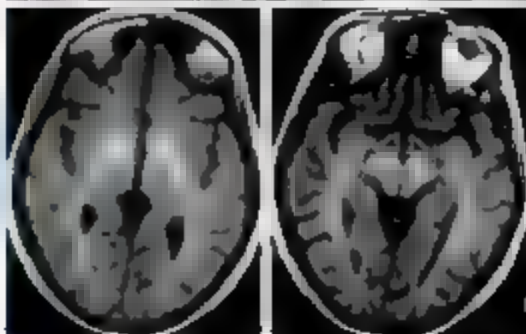
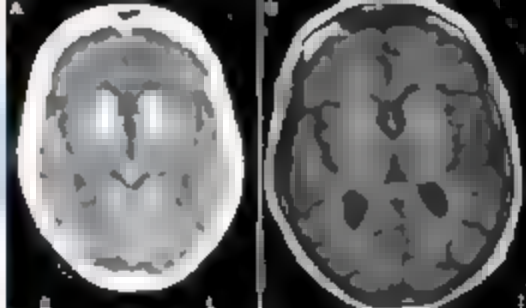


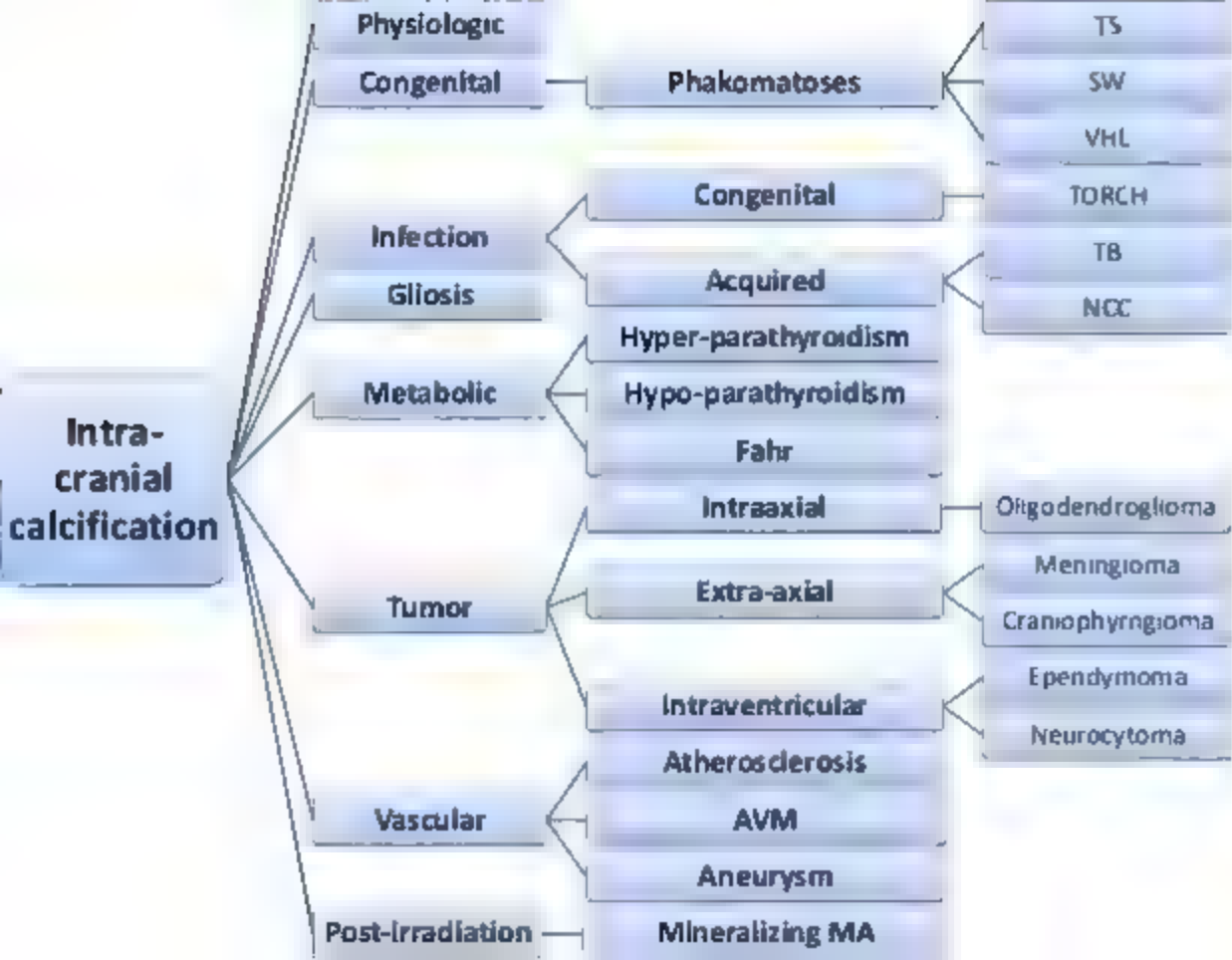
Classification



Diagnosis







**Oligodendro-
glioma**



**Sub-
ependymoma**



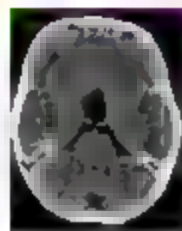
Ependymoma



**Central
neurocytoma**



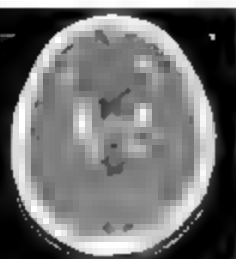
**Cranio-
pharyngioma**



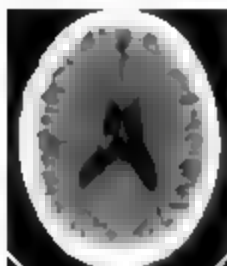
Meningioma



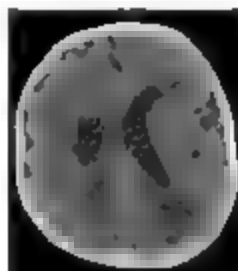
**Hyper-
parathyroidism**



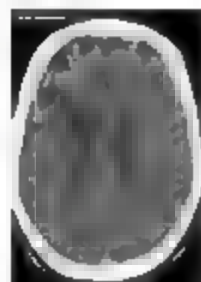
**Mineralizing
microangiopathy**

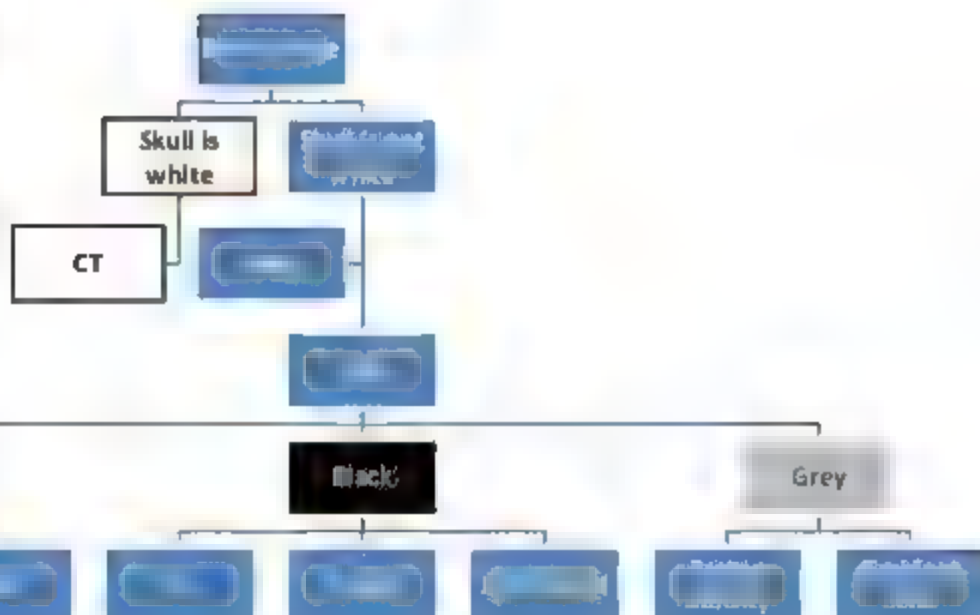
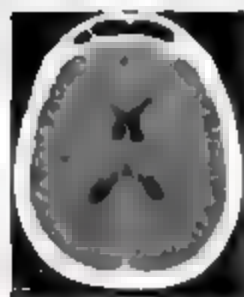


TORCH



**Cavernous
malformation**





T2

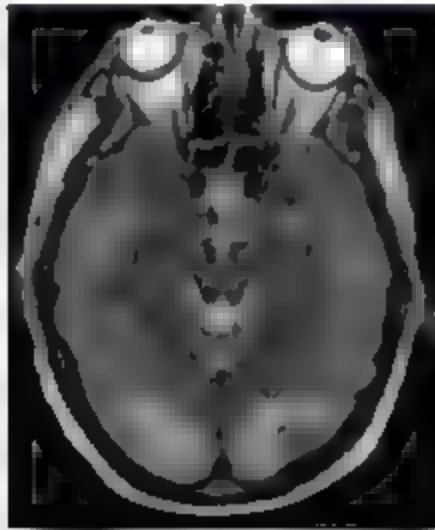
- Brain edema.
- Encephalomalacia / gliosis.
- Demyelination plaques (posterior fossa).

Brain edema

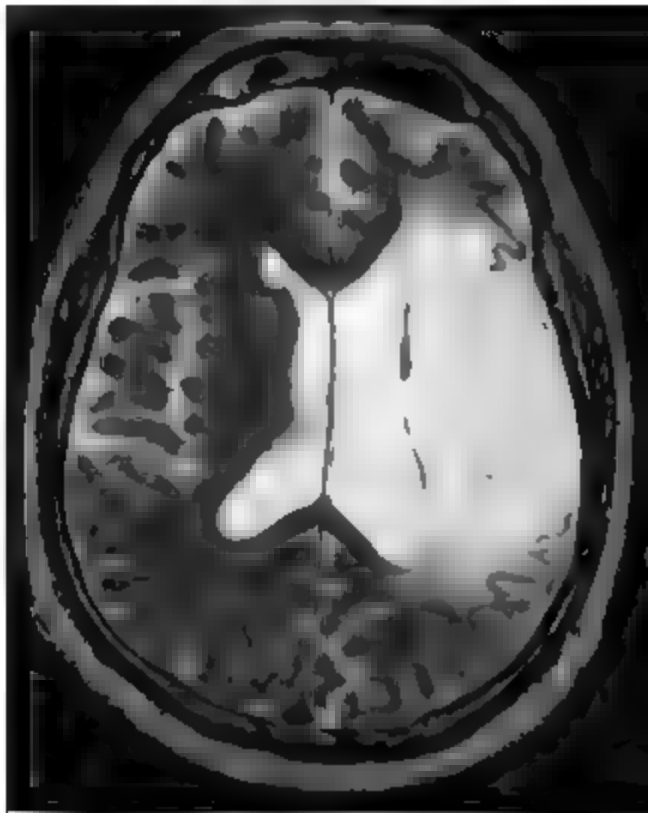
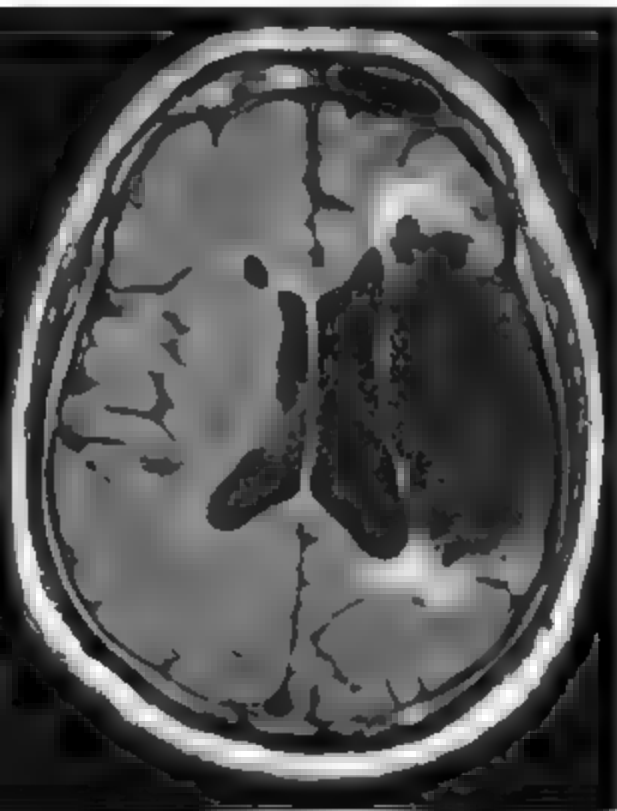
Cyto-toxic

Vaso-genic

Interstitial

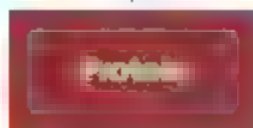
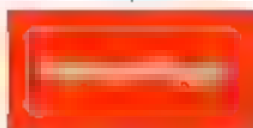


Encephalomalacia vs gliosis

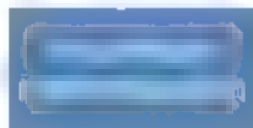
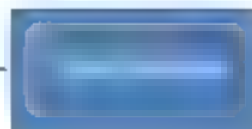
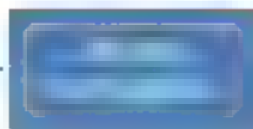
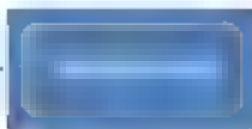


Low signal on T2

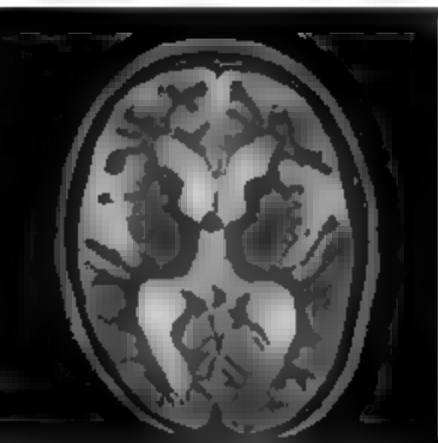
Contrast
(Perfusion)



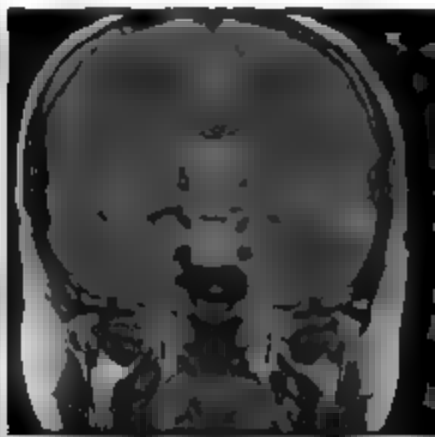
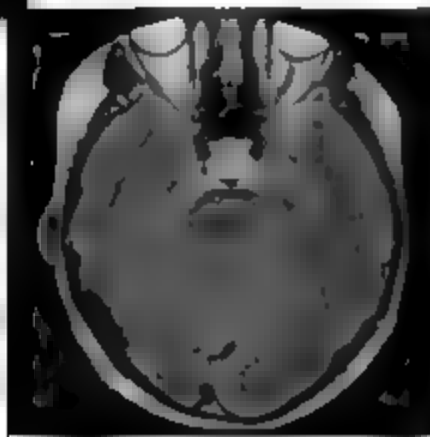
Minerals



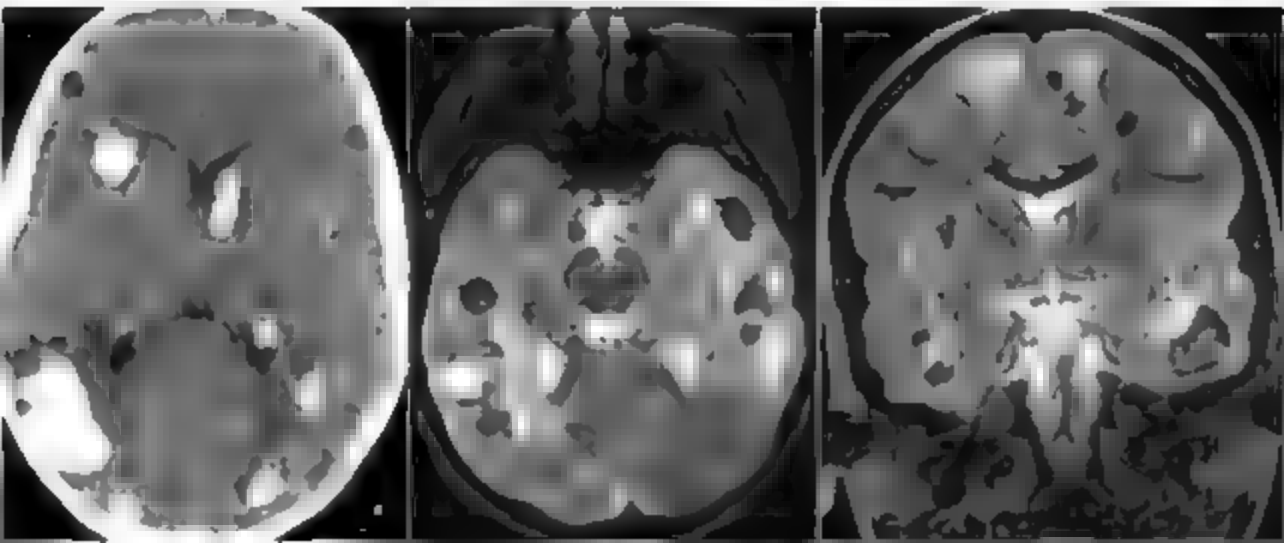
Black hole effect



Intra-cystic nodule of low signal

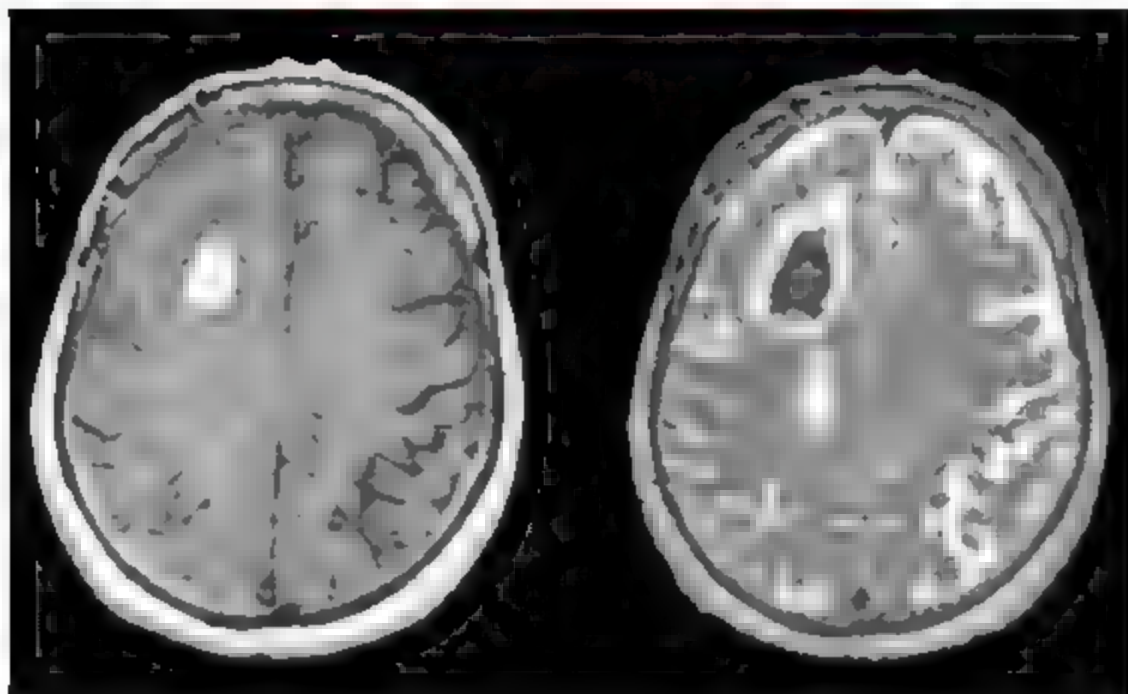


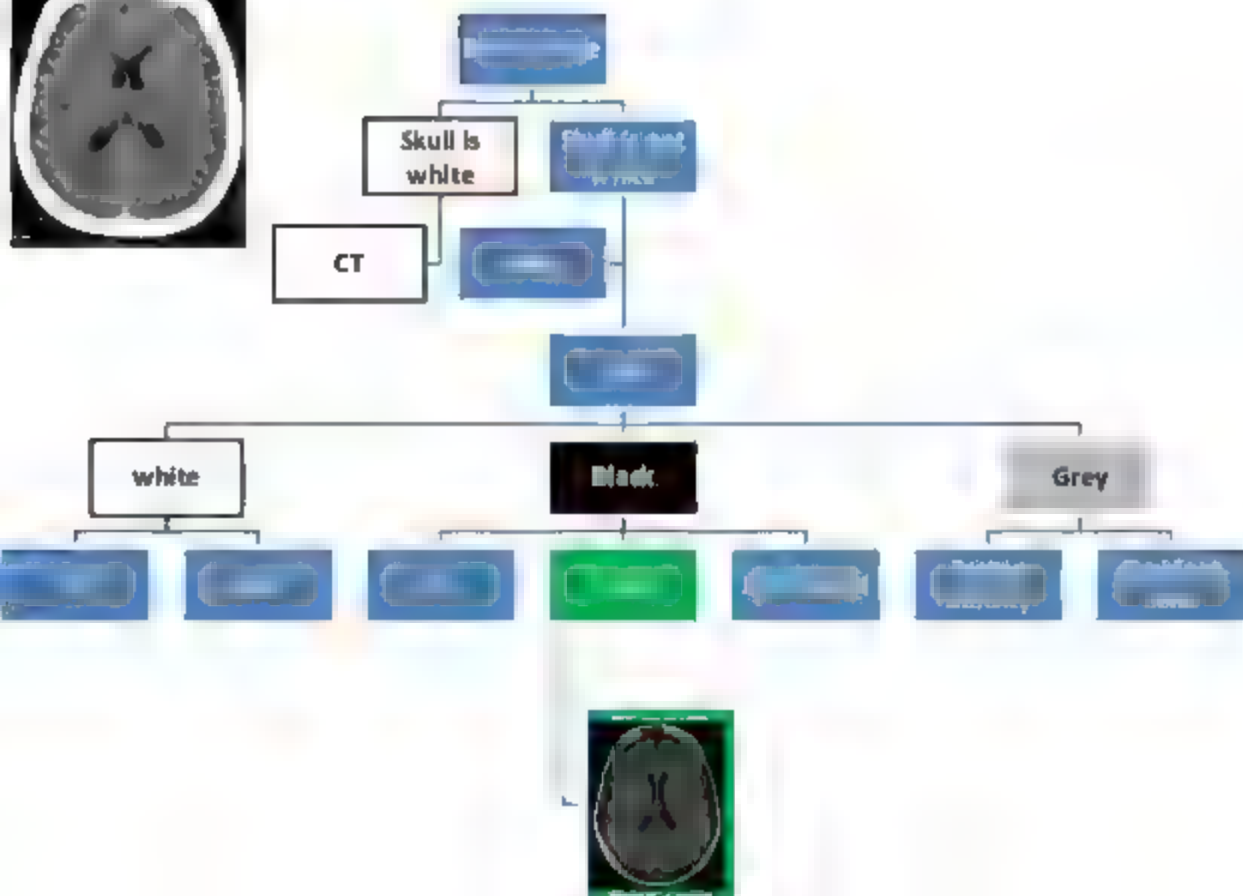
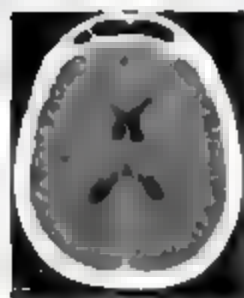
Calcification



Acute intracerebral hematoma

de-oxy hemoglobin





FLAIR

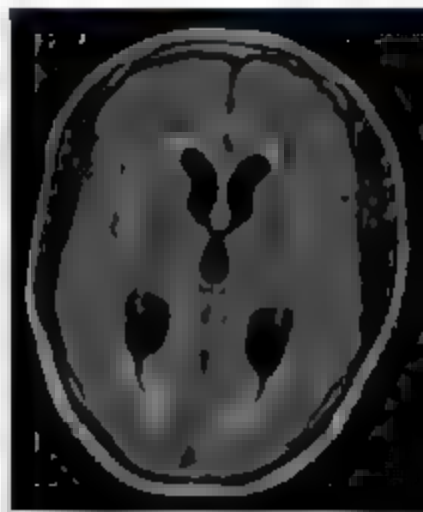
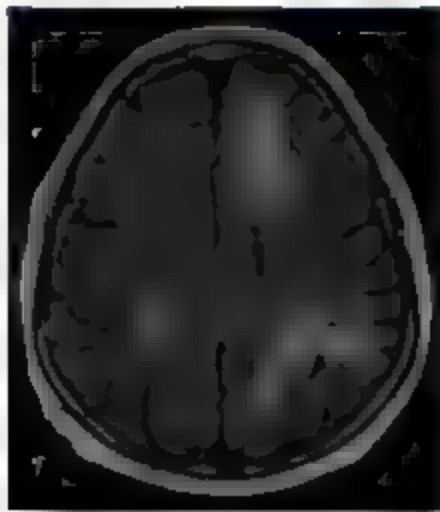
- Brain edema.
- Gliosis.
- Demyelination plaques.
- Subarachnoid hemorrhage.

Brain edema

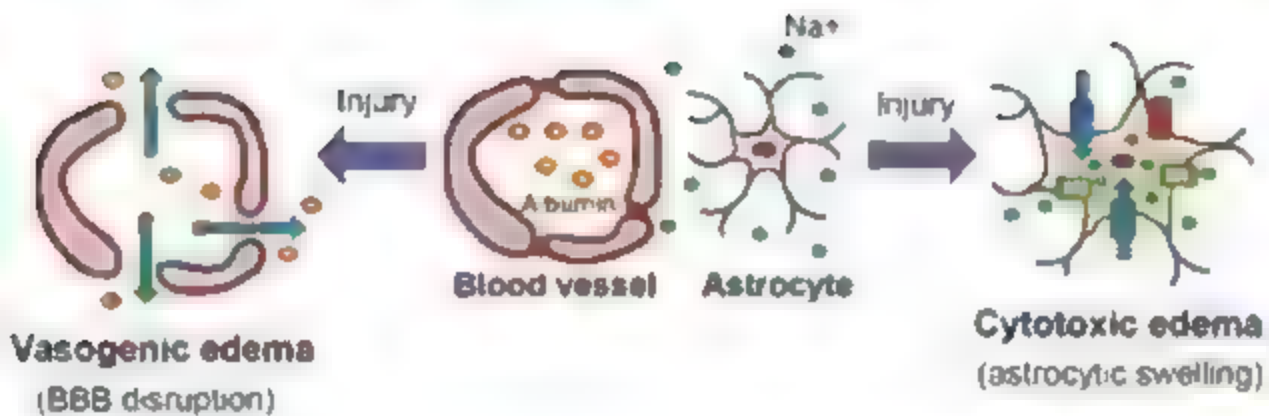
Cyto-toxic

Vaso-genic

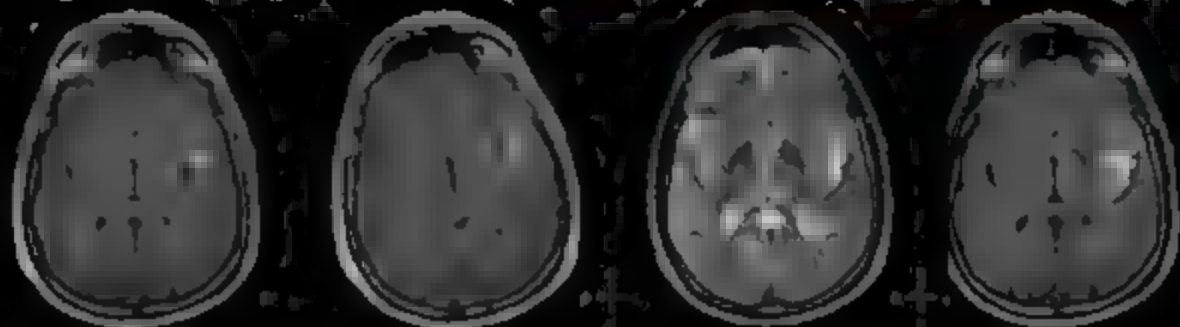
Interstitial



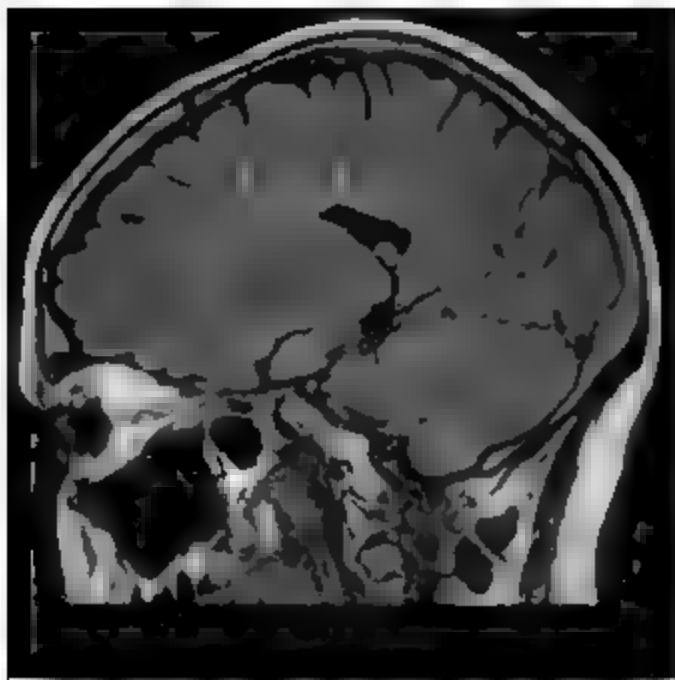
	Cytotoxic	Vasogenic	Interstitial
	Intra-cellular edema	Extra-cellular edema	Trans-ependymal CSF permeation
Pathogenesis	Na / k pump failure	Disrupted BBB	increased intraventricular pressure
Causes	Infarction.	Infarction. Tumor. Infection PRESS	Hydrocephalus
Location	Grey and white matter	White matter	Periventricular white matter
T2	Loss of corticomedullary differentiation	Finger like	Periventricular rim.
Diffusion	Restriction	No restriction	No restriction



Subarachnoid hemorrhage

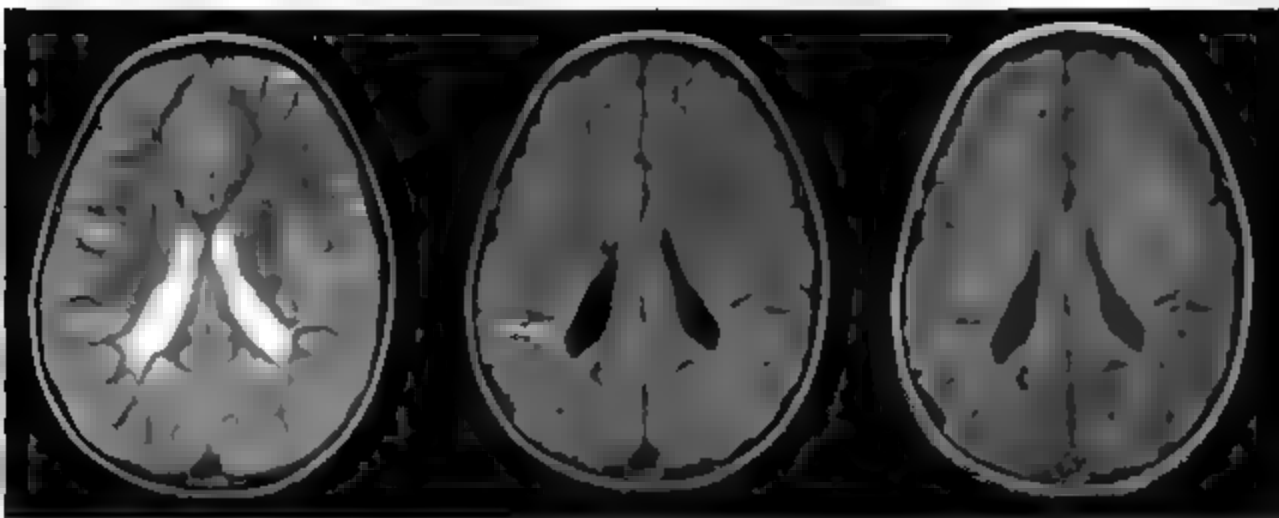


MS



Gliosis

- Periventricular leukomalacia.



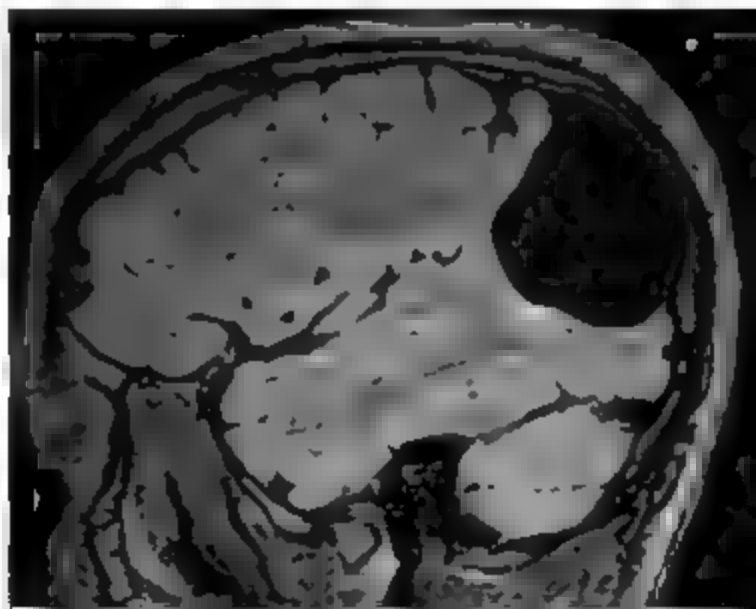
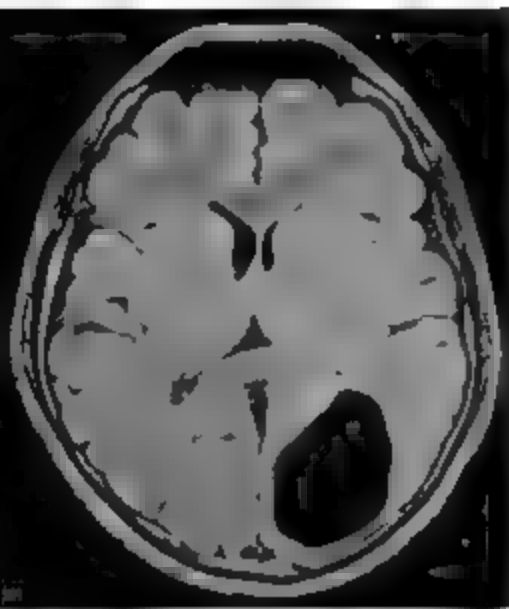
T2w

FLAIR

T1w

Gliosis

- *Neuro-epithelial* cyst Vs *Porencephalic* cyst

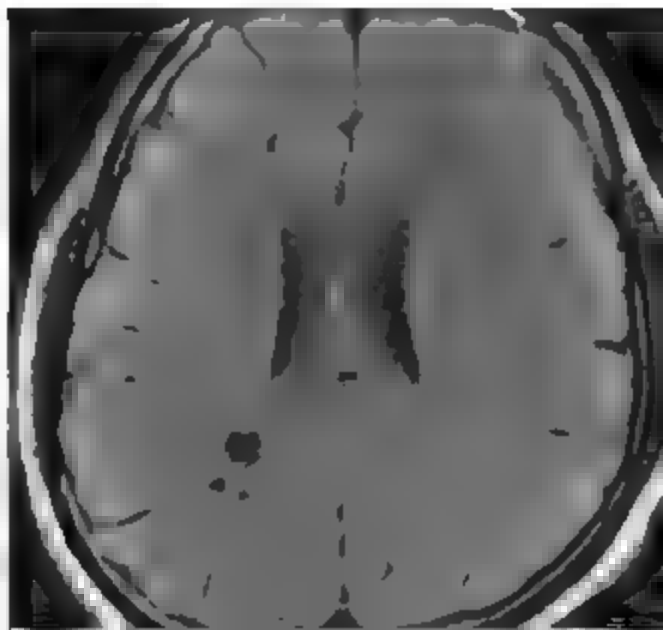


Gliosis

Lacunar infarct

vs

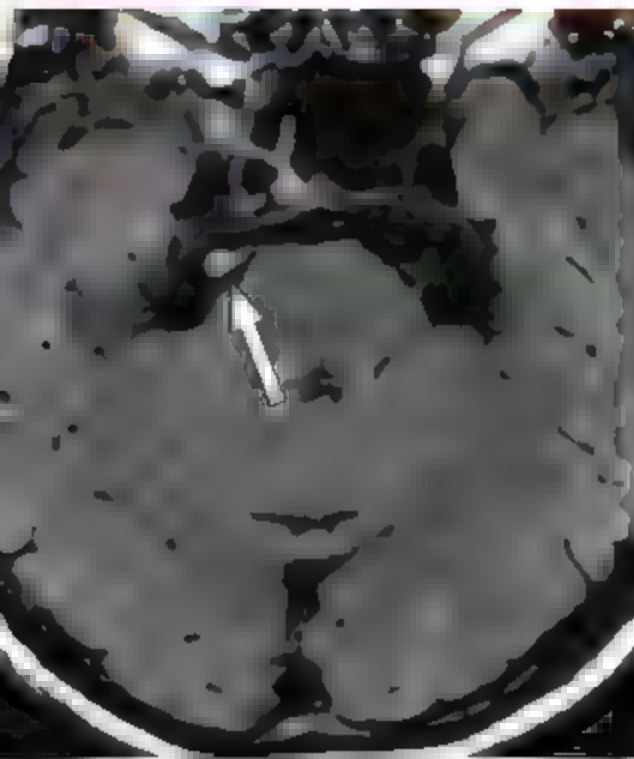
Virchow Robin space



Disadvantages of FLAIR

- CSF flow artifact.
- False negative FLAIR.

CSF flow artifact



False negative FLAIR

T1

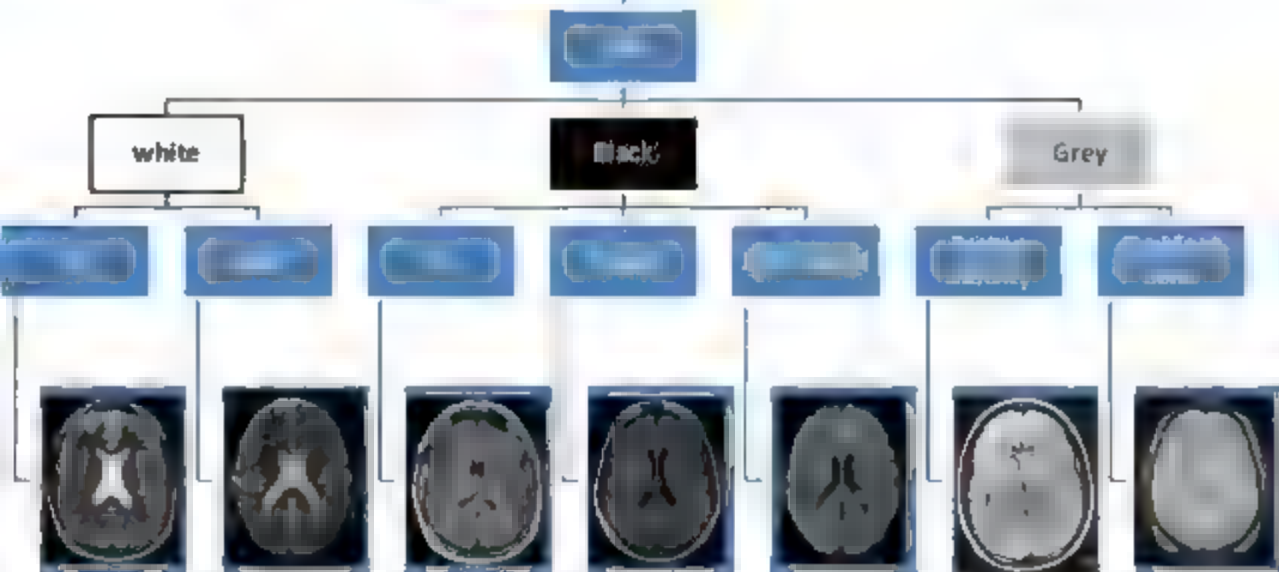
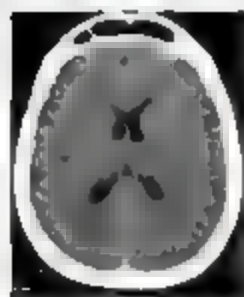


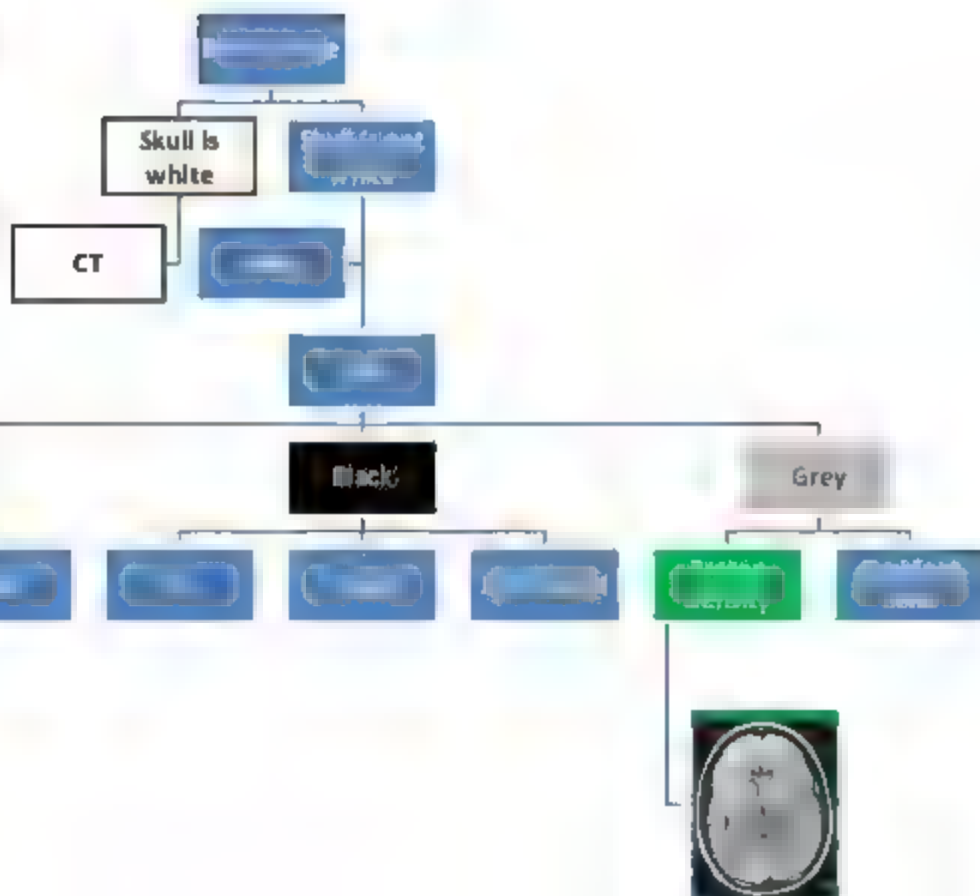
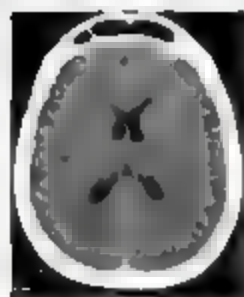
T2



FLAIR

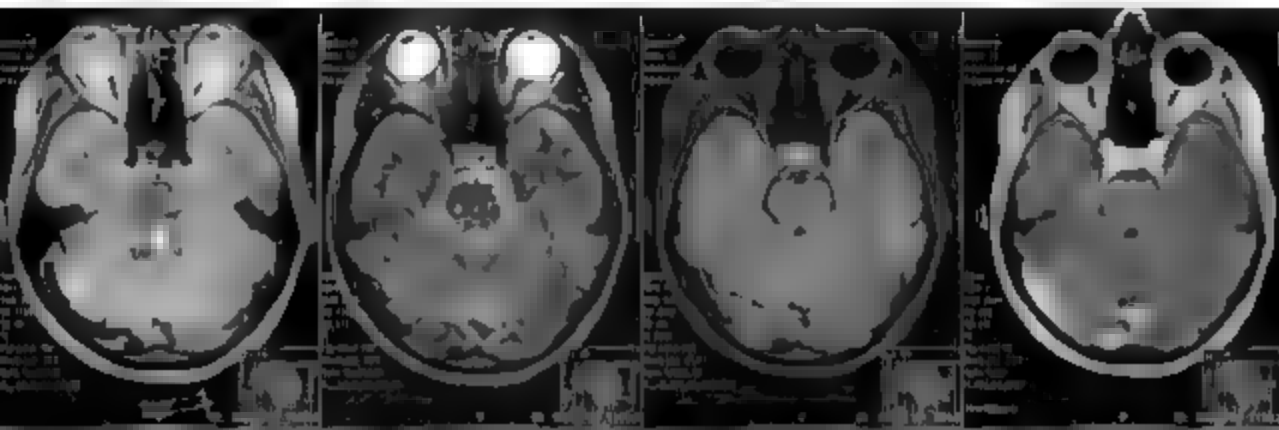


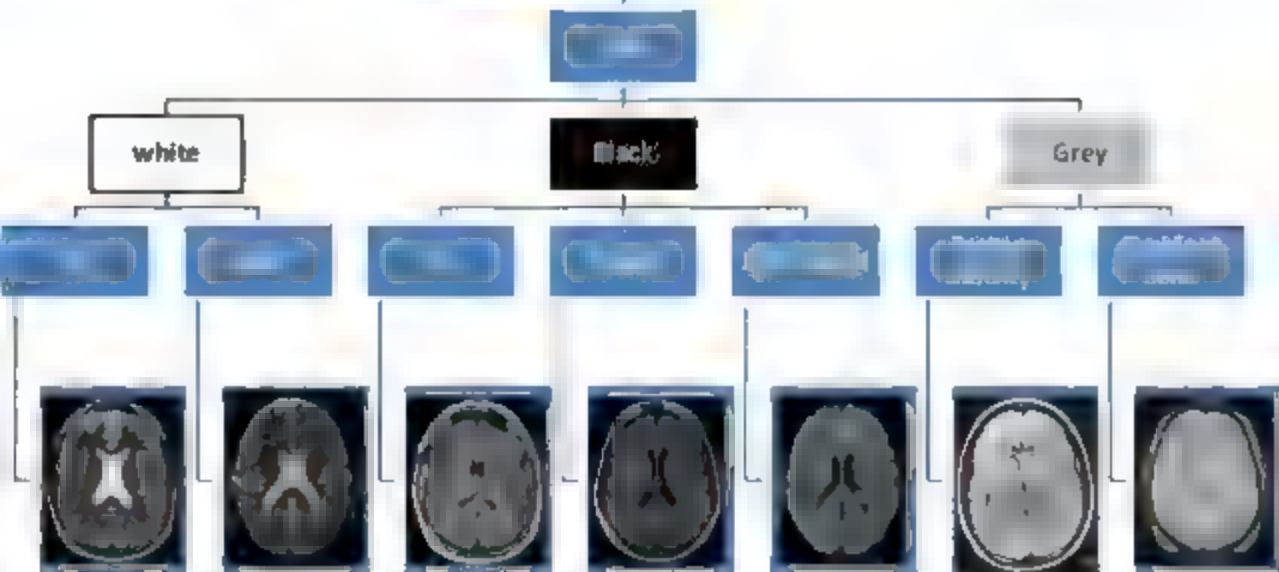
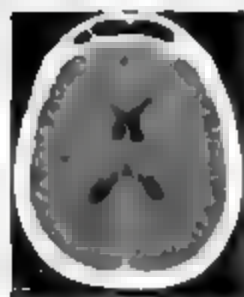


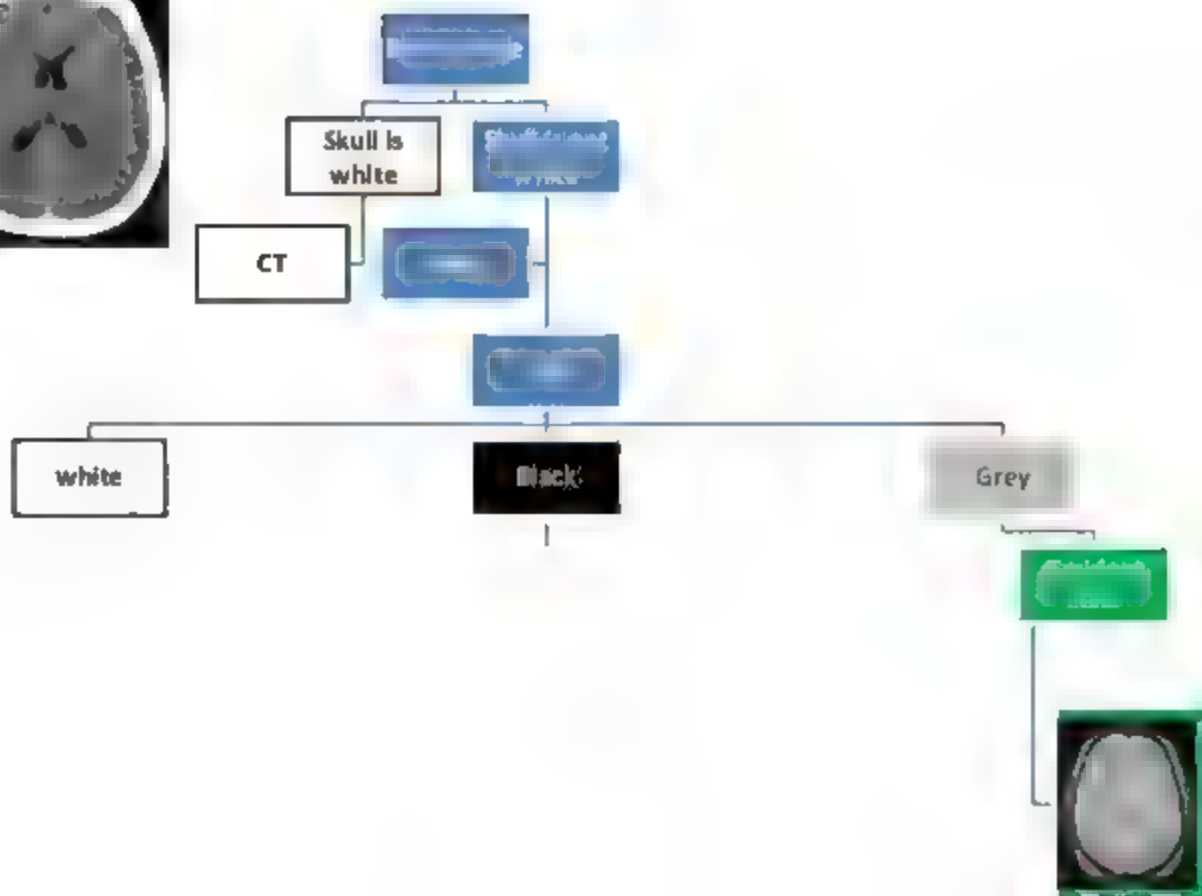
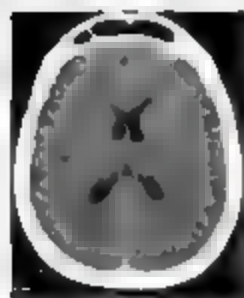


Detection of MS plaques

- *PD is the king* under tentorium.





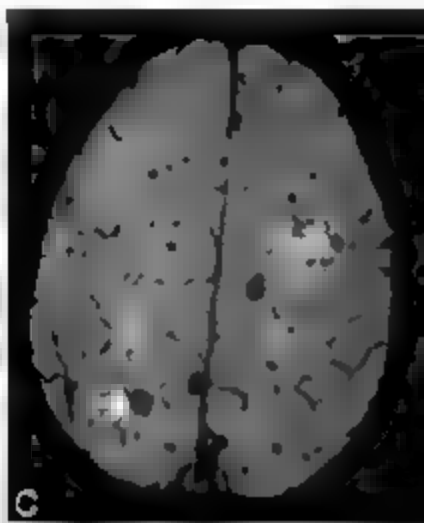
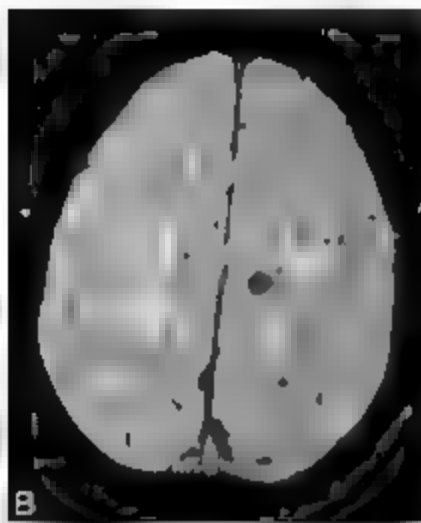


Gradient T2* WIS

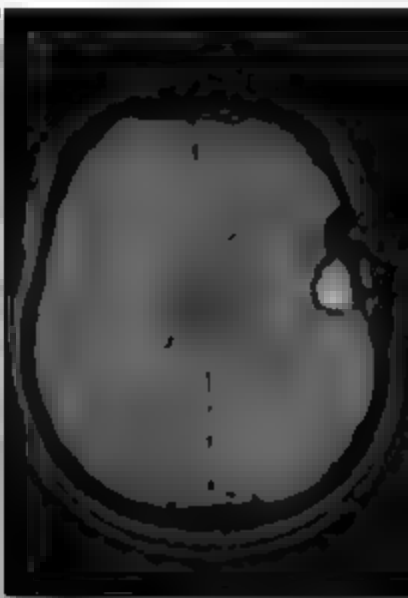
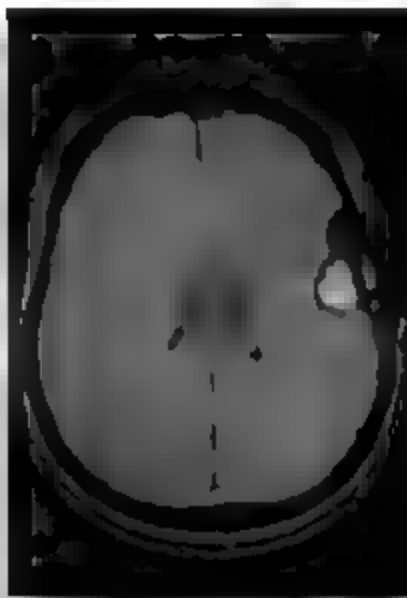
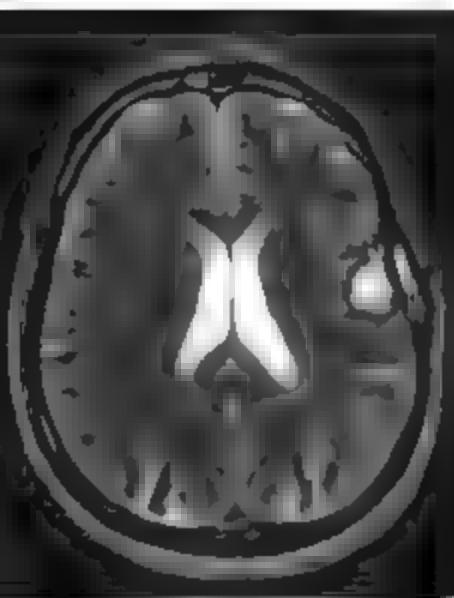
Sensitive to de-oxy hemoglobin and hemosiderin because of their susceptibility effects.

- Cavernous malformations.
- Amyloid angiopathy.
- Post-radiation capillary telangiectasia.

Cavernous malformations



Post-radiation capillary telangiectasia

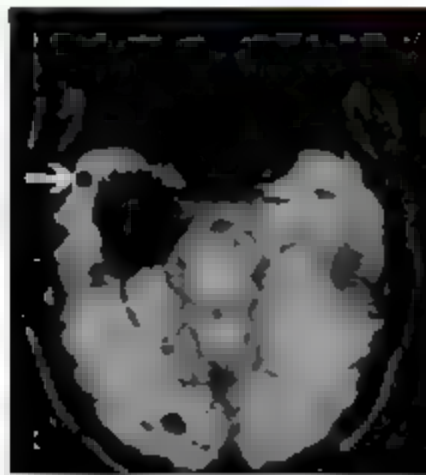
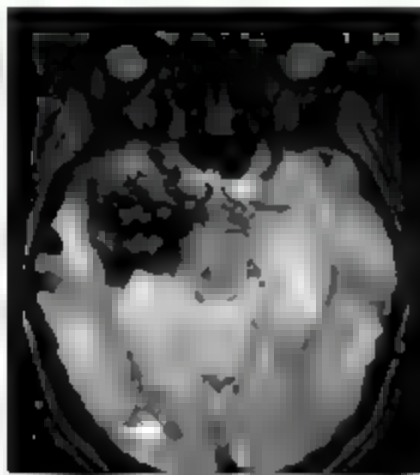


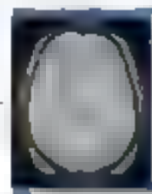
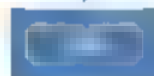
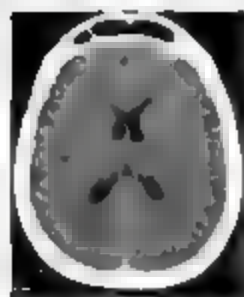
Disadvantages of Gradient T2WIs

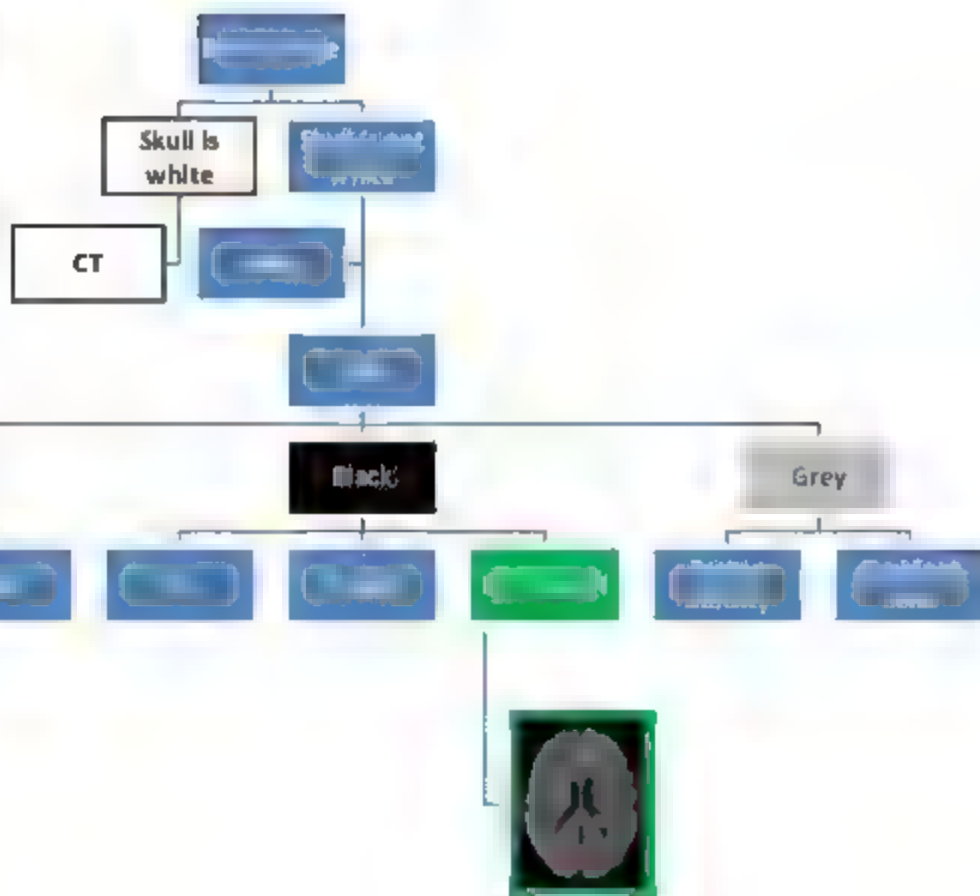
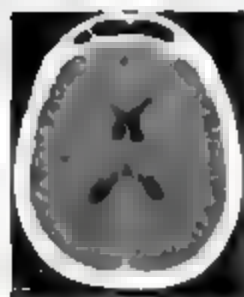
- Blooming artifact.

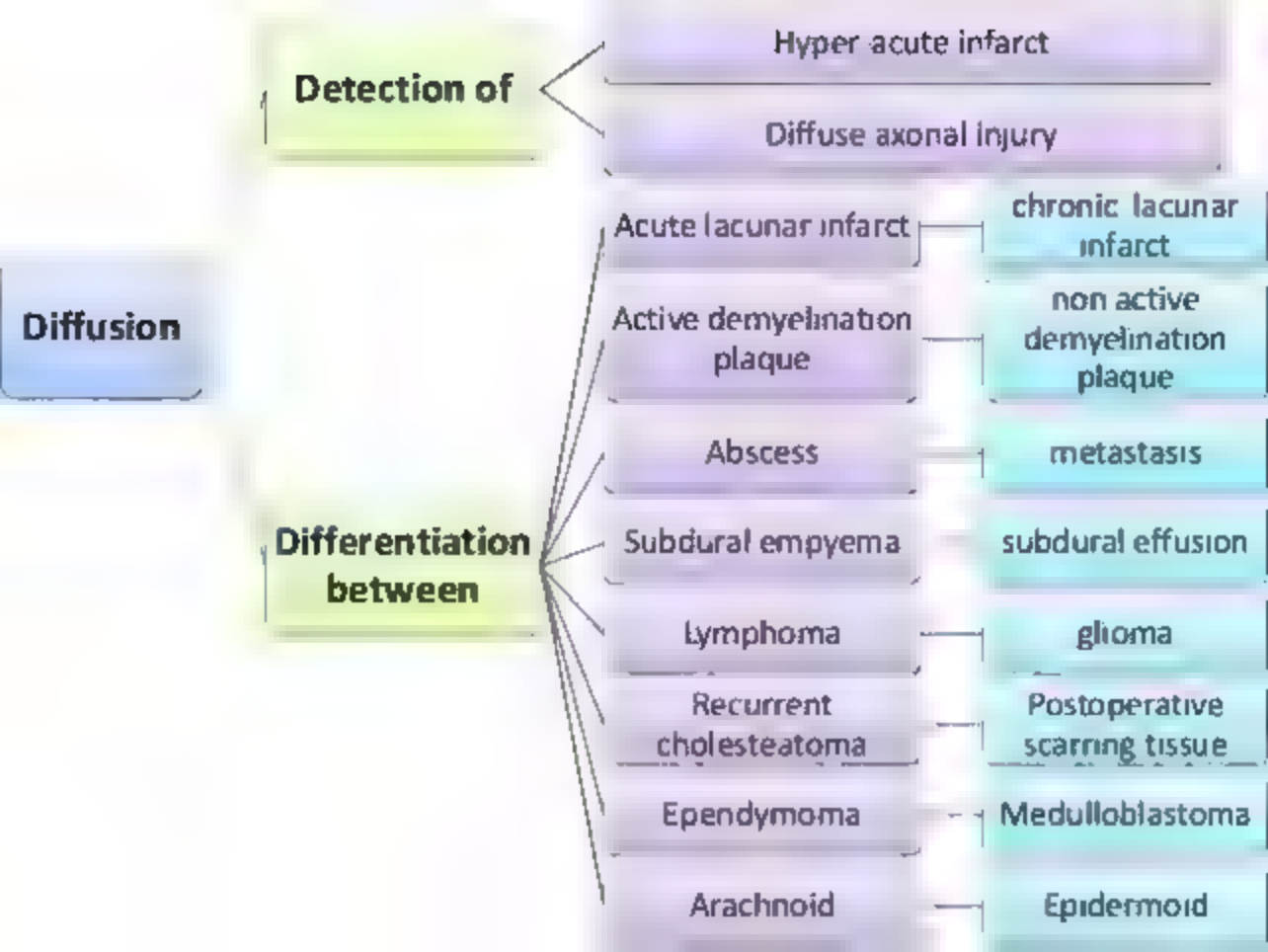
Blooming artifact

- Obscure adjacent smaller lesions

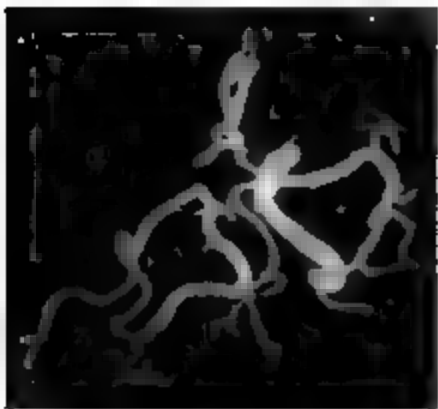




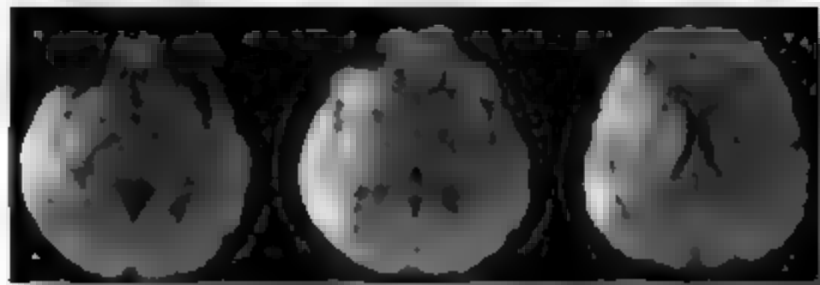
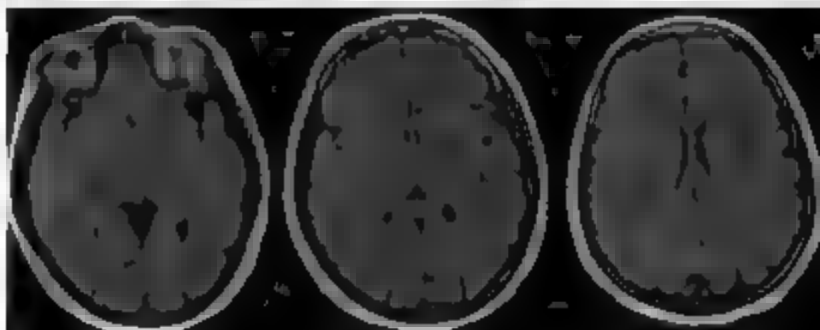
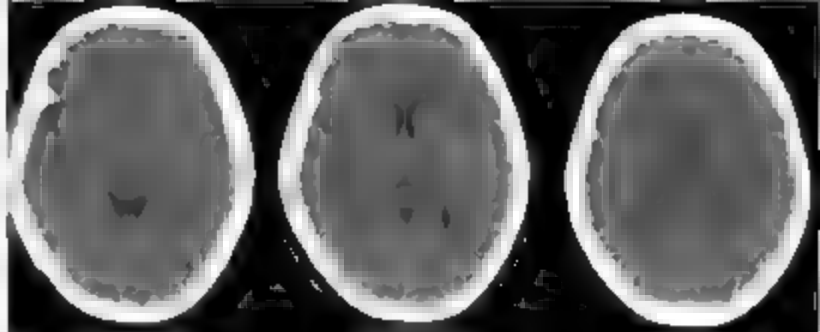




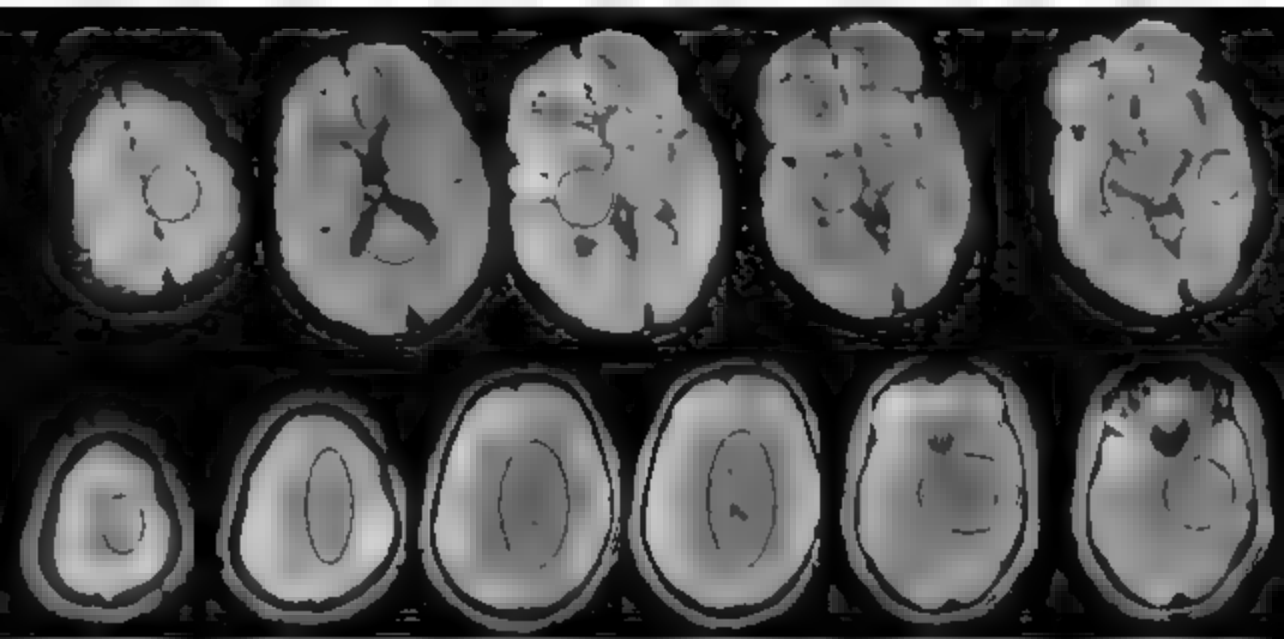
Hyper-acute stroke



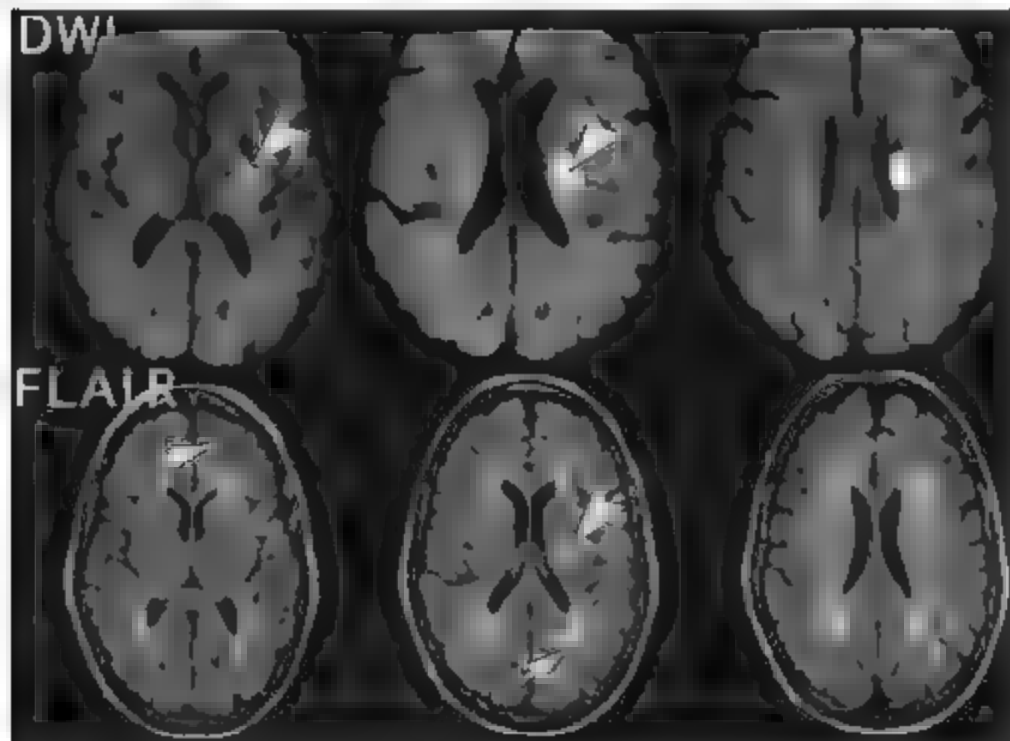
- FLAIR / Diffusion mismatch



Diffuse axonal injury



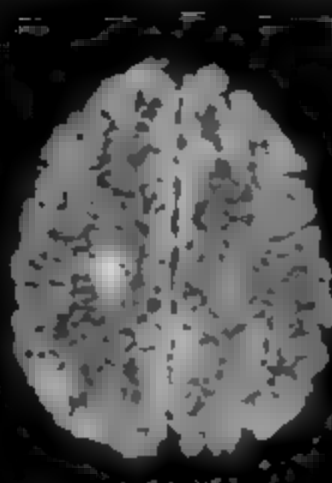
Acute vs chronic lacunar infarcts



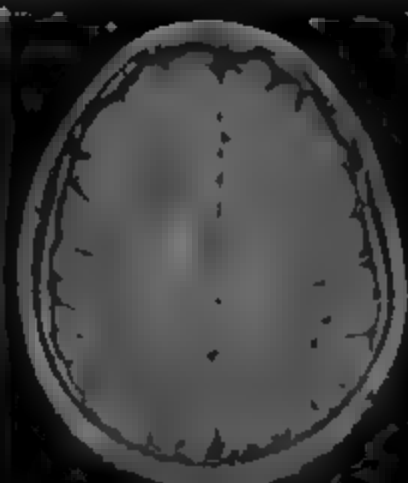
Active demyelination plaque



T1 with Gad
subtle enhancement



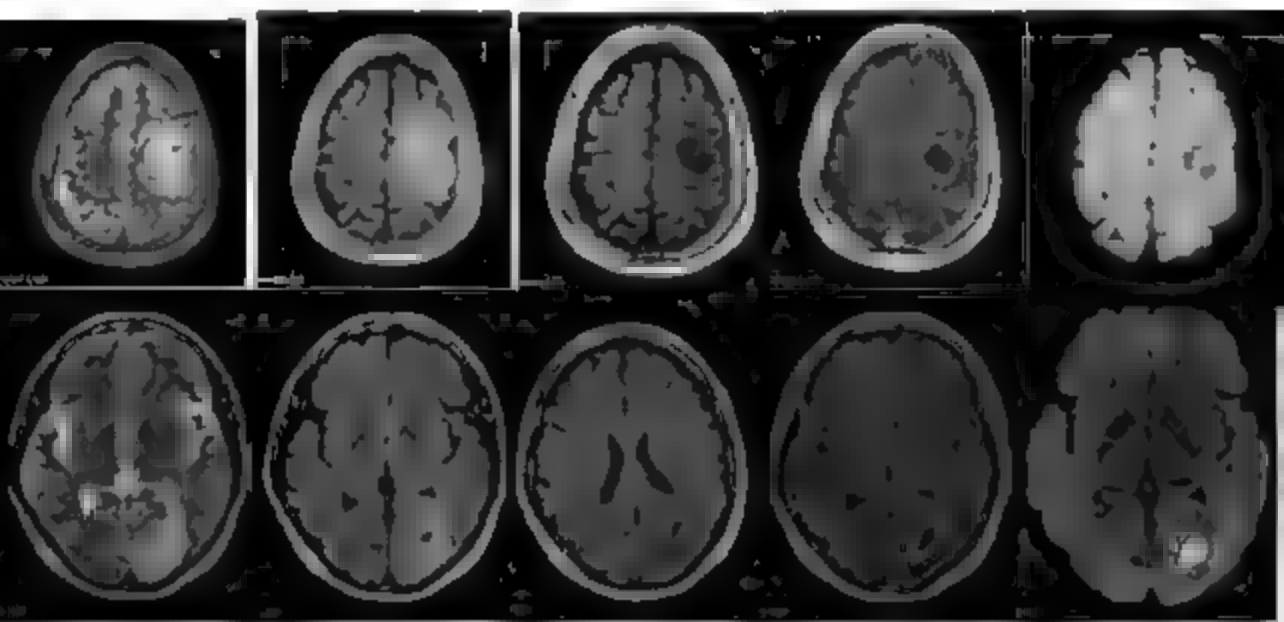
DWI acute restricted
diffusion



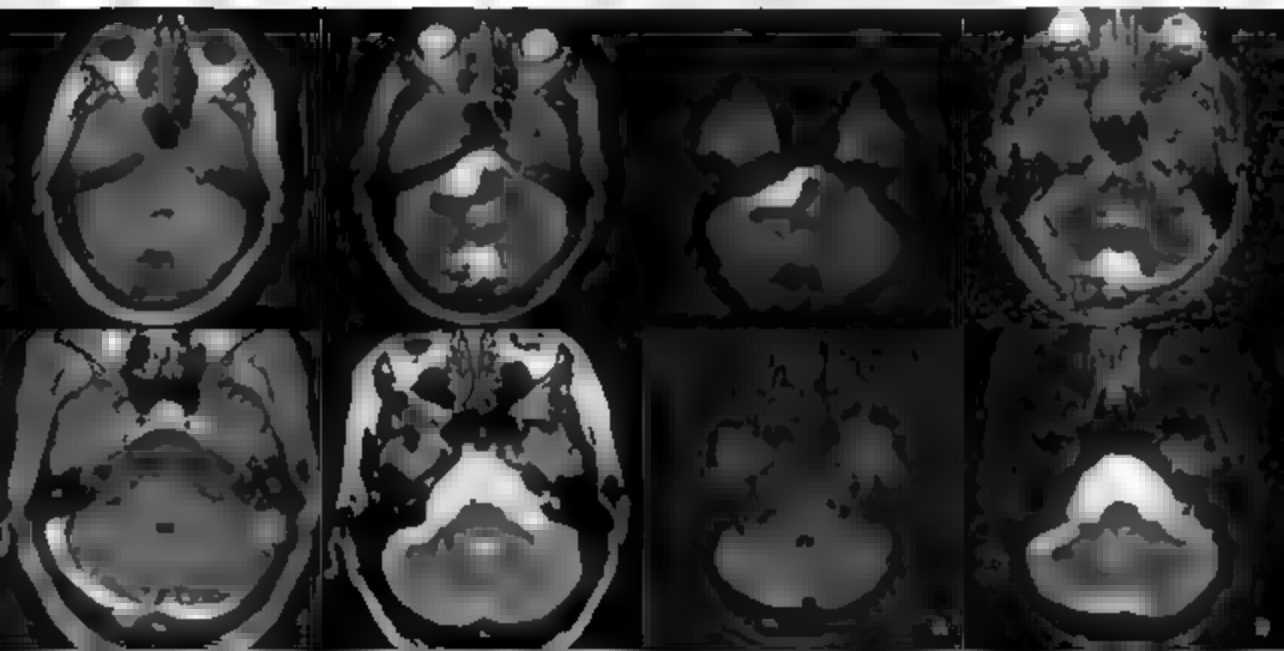
Matching FLAIR
abnormality

Abscess vs metastasis

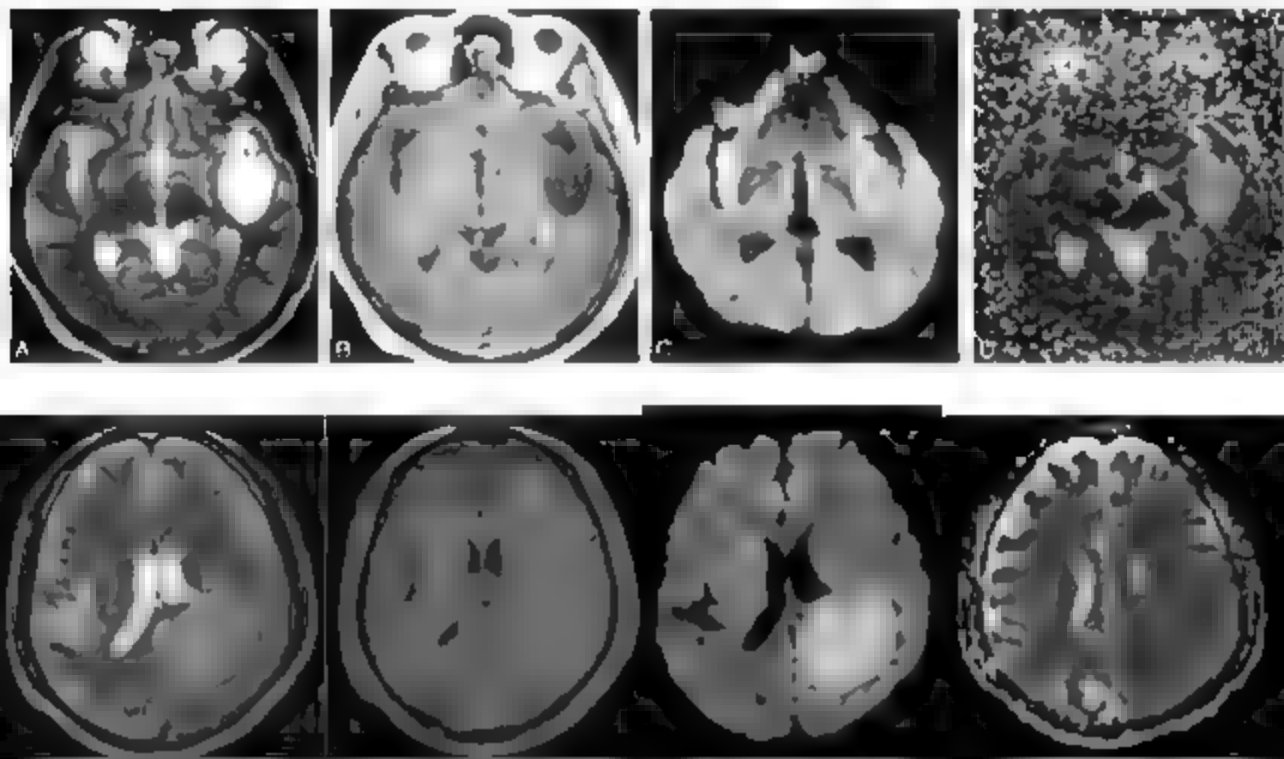
- High viscosity of pus \rightarrow restricted diffusion



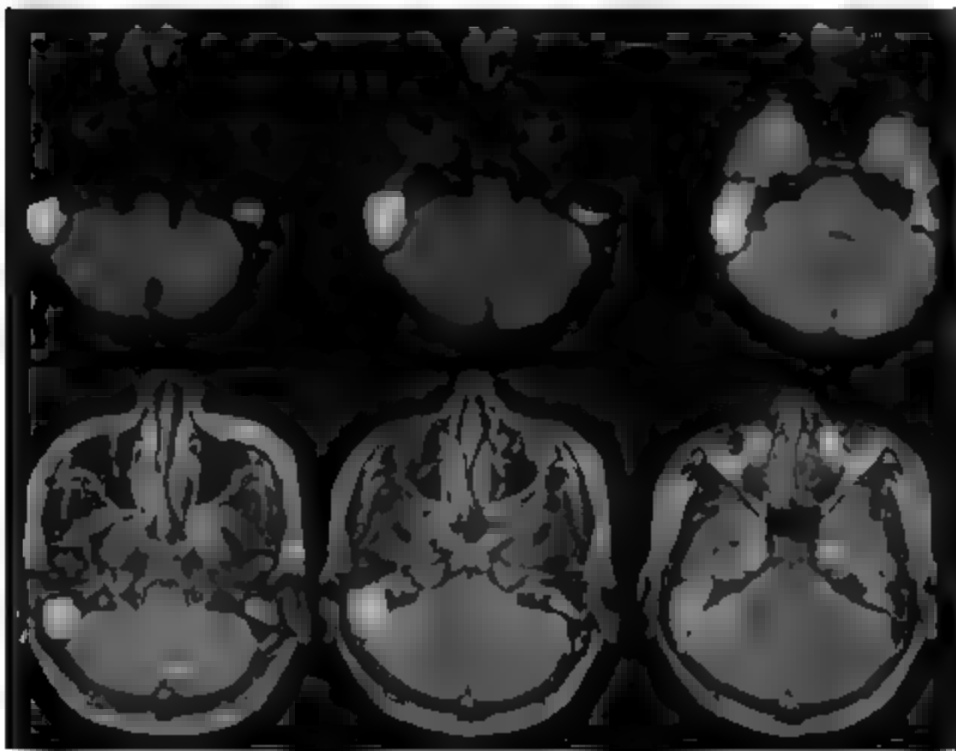
Arachnoid vs epidermoid



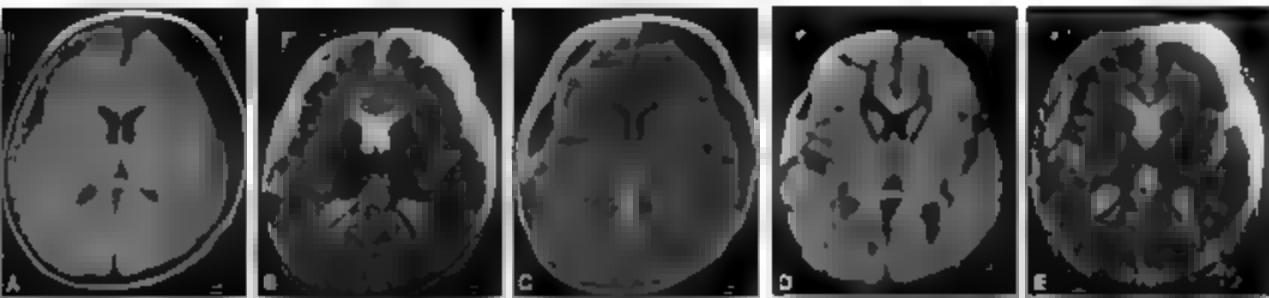
Glioma vs lymphoma



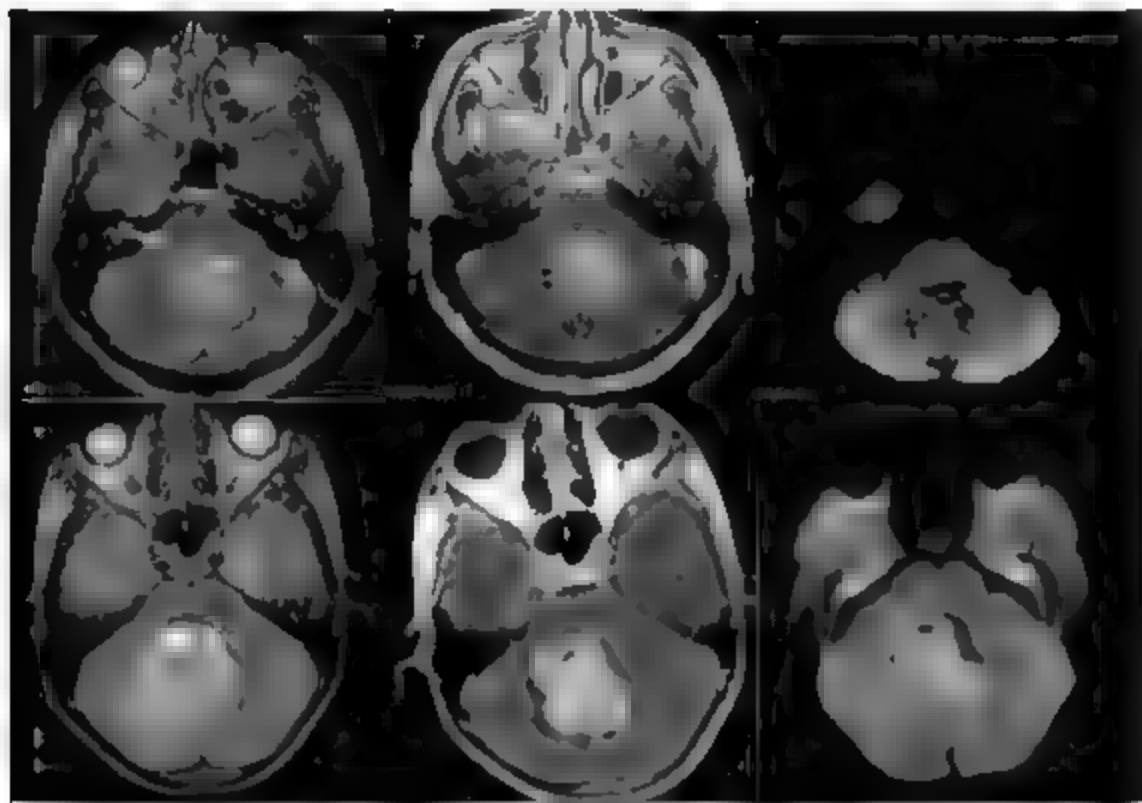
Recurrent cholesteatoma vs post-operative scarring tissue



Subdural empyema vs subdural effusion



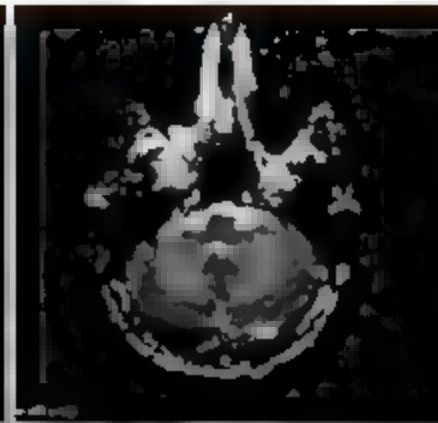
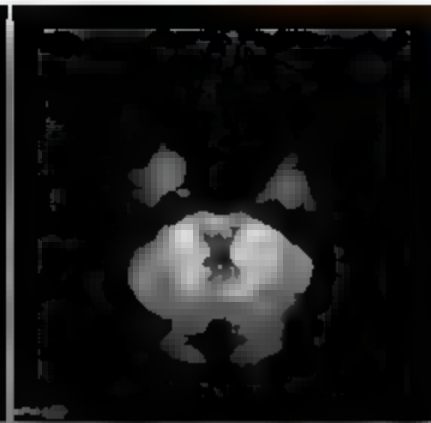
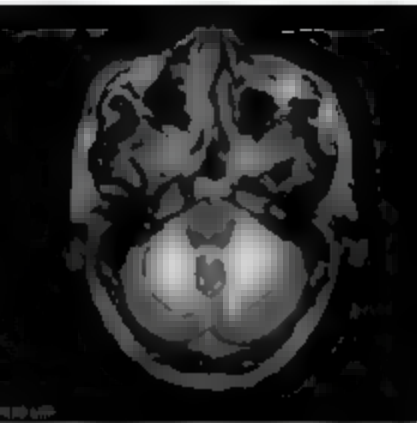
Ependymoma vs medulloblastoma



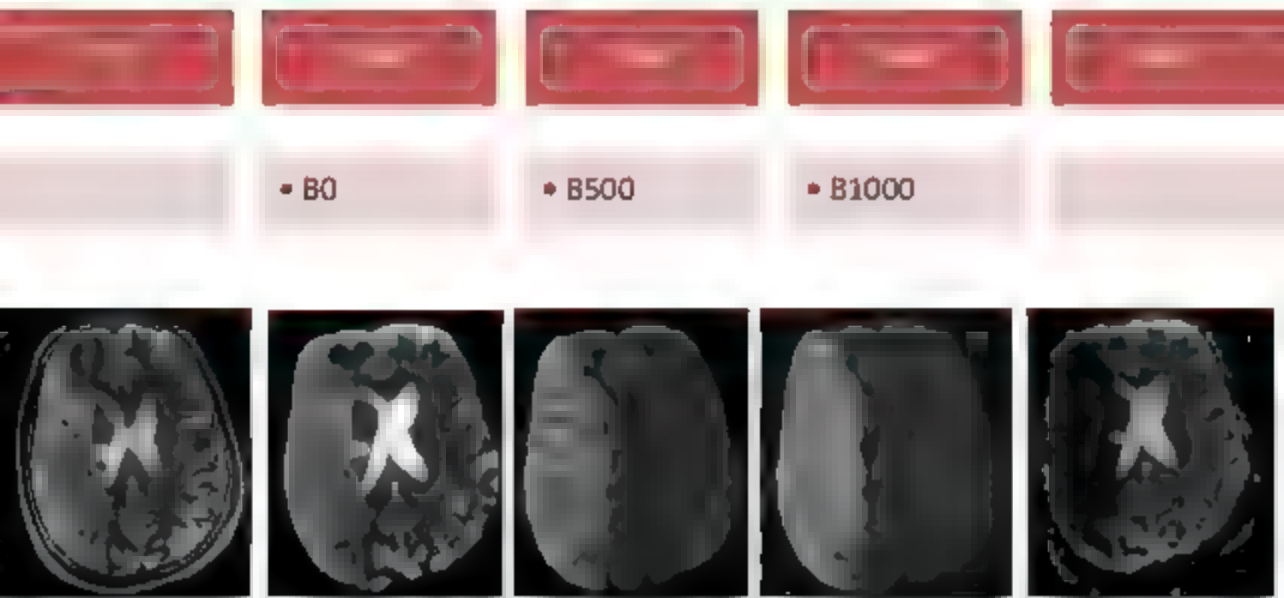
Diffusion artifacts

- T2 shine through effect.
- Anisotropic diffusion.

T2 Shine through artifact



Restricted diffusion vs T2 shine through



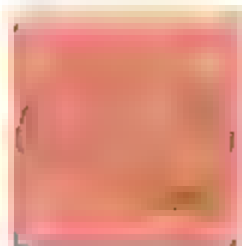
Anisotropic diffusion



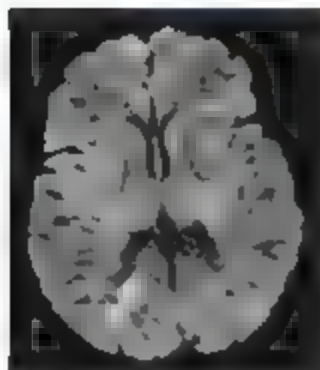
Coronal



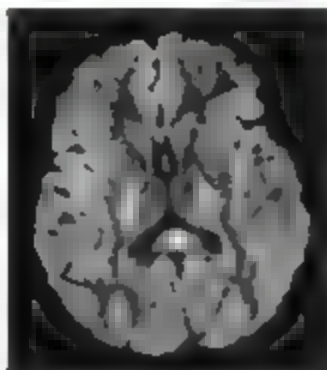
Axial



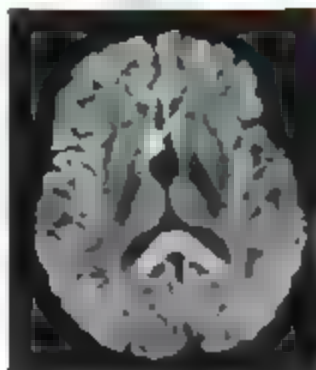
Sagittal



Gx



Gy



Gz

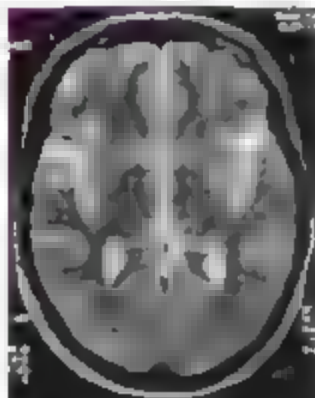
Advanced MRI techniques

- MR spectroscopy.
- MR perfusion.
- DTI
- Tractography.

What is MRS?

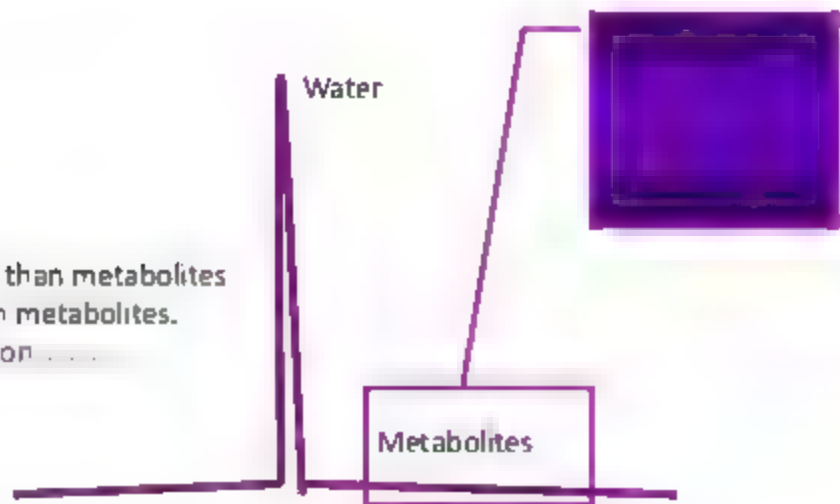
- It is an MRI technique whereby the echo that is obtained from the body is analyzed into its various radio-frequency components rather than making an image.

Echo Analysis



Suppression Techniques

- Water is 100,000 X than metabolites
- Fat is 10,000 X than metabolites.
-need suppression



CHES = Chemical Shift Suppression.

WEFT = Water Elimination Fourier Transform Tech.

I.R Pulses to null water signal prior to spectroscopy

Requirements

- **High Field.**
 - 1.5 T & 3T.
- **High Homogeneity**
 - Less than 0.2 p.p.m
 - Assessed by measuring the water peak width.



Metabolites

- NAA: Neuronal marker (2.0 ppm)
 - Neuronal marker
 - Any neuronal loss.....decrease NAA.
- Choline: Cell membrane. (3.2 ppm)
 - High cellularity & membrane turn over increase Choline
- Creatine: energy marker. (3.0 ppm)



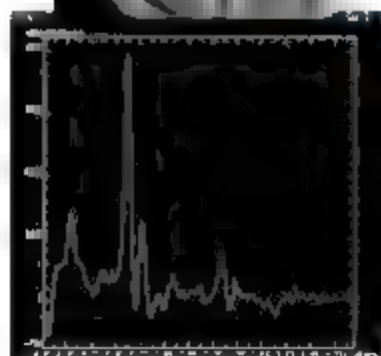
Metabolites

- **Lactate: Cell death.** (1-3 ppm)
 - Necrosis & hypoxia (anaerobic glycolysis) .. increase Lactate.
- **Lipid:** (1-3-15 ppm)
 - Necrosis
- **Myo-Inositol:** (3-5 ppm)
 - Decreases in High grade malignancy

Single vs. Multi-Voxel Spectroscopy

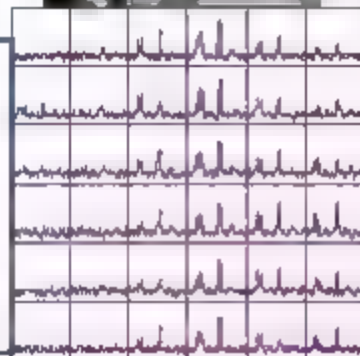
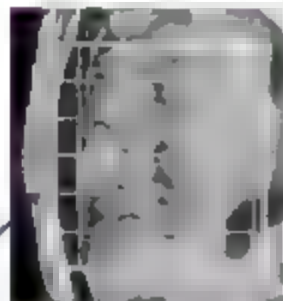
Single Voxel

- 2X2X2 cm cube
- Short TE (STEAM)
 - TE=30-35 msec
- All Metabolites
- Lesion = 60-80%

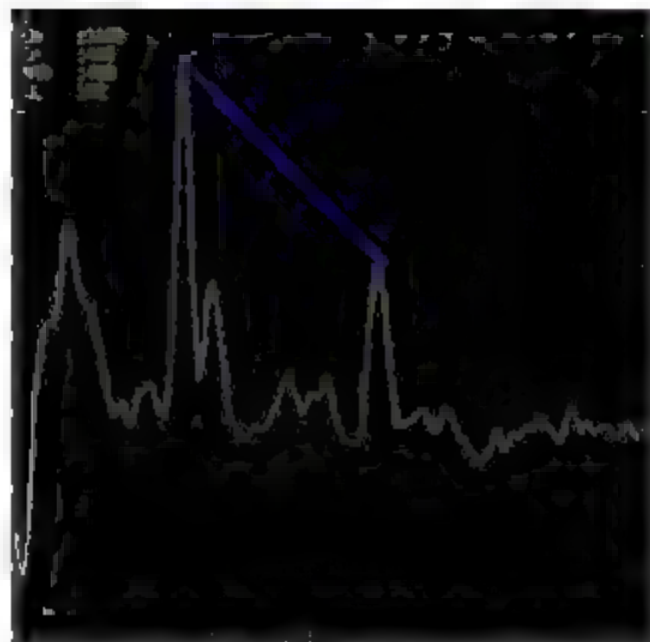


Multi Voxel

- 2X2X2 cm cube
- 2-3mm inner cubes
- Long TE (PRESS)
 - TE=135-260 msec
- Major Metabolites
- Margin outline



MRS

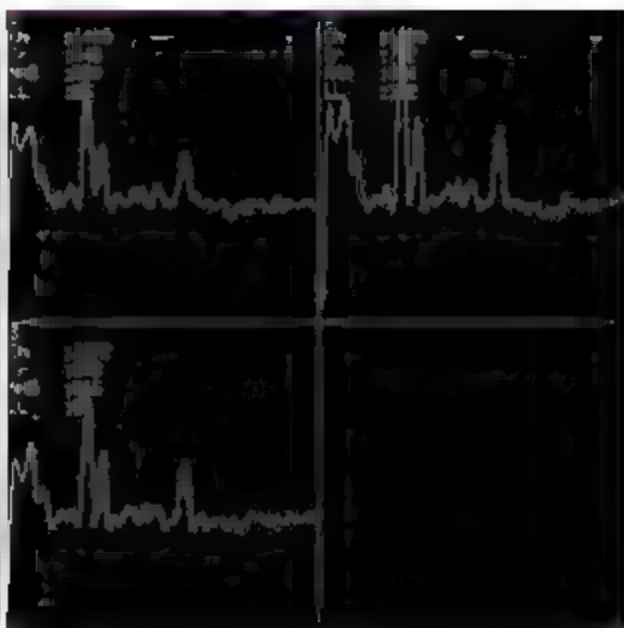
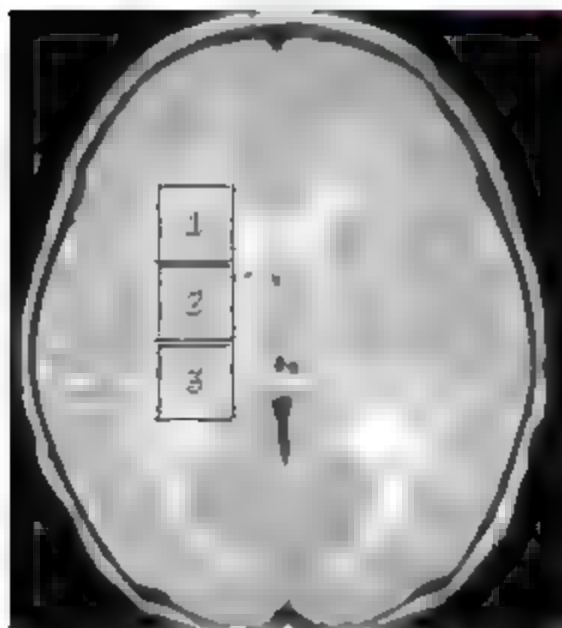


Infant



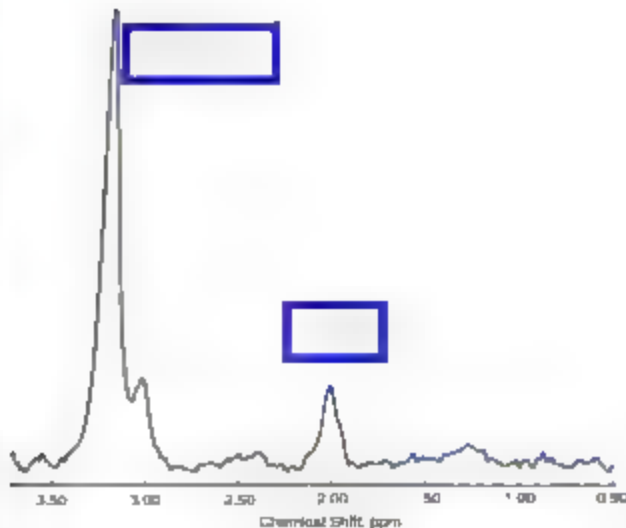
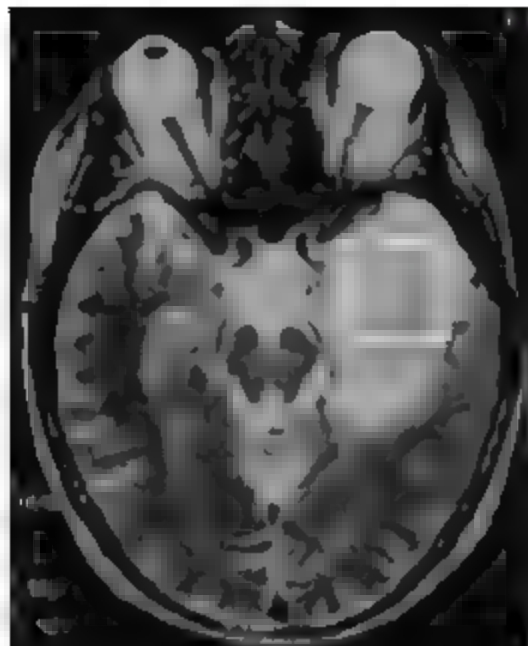
Adult

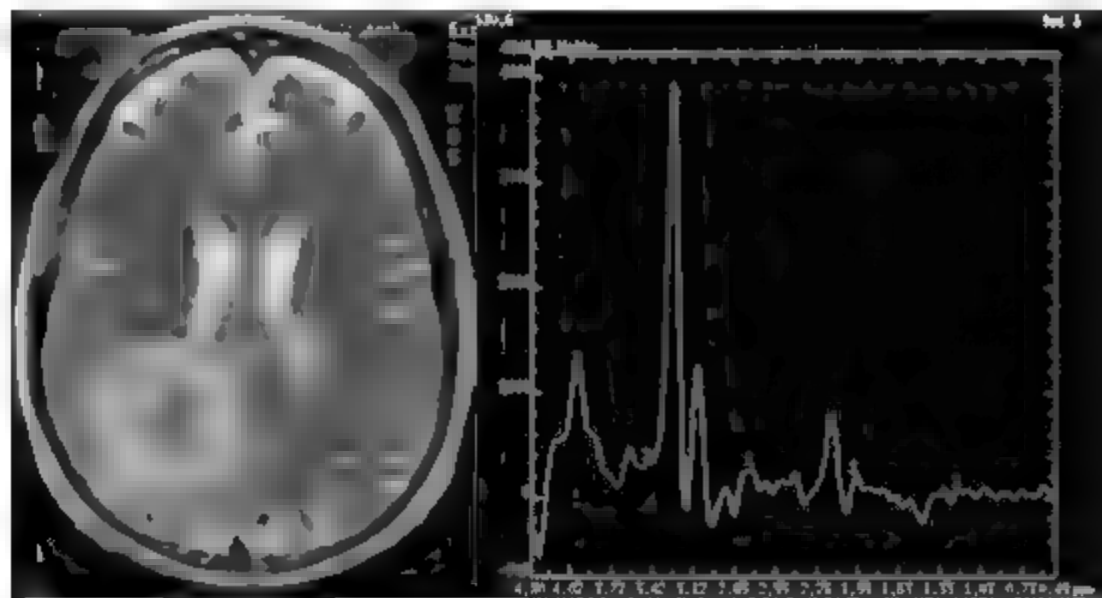
MRS for 6 days

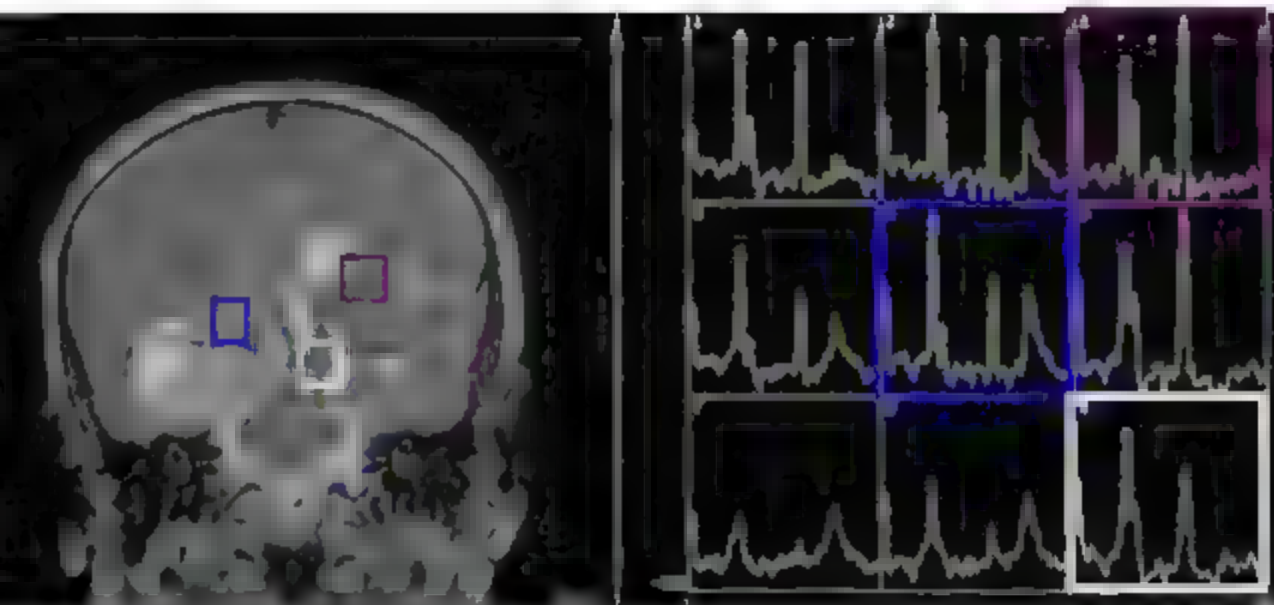


Tumour

- Increased Choline
- Increased Cho:Cr

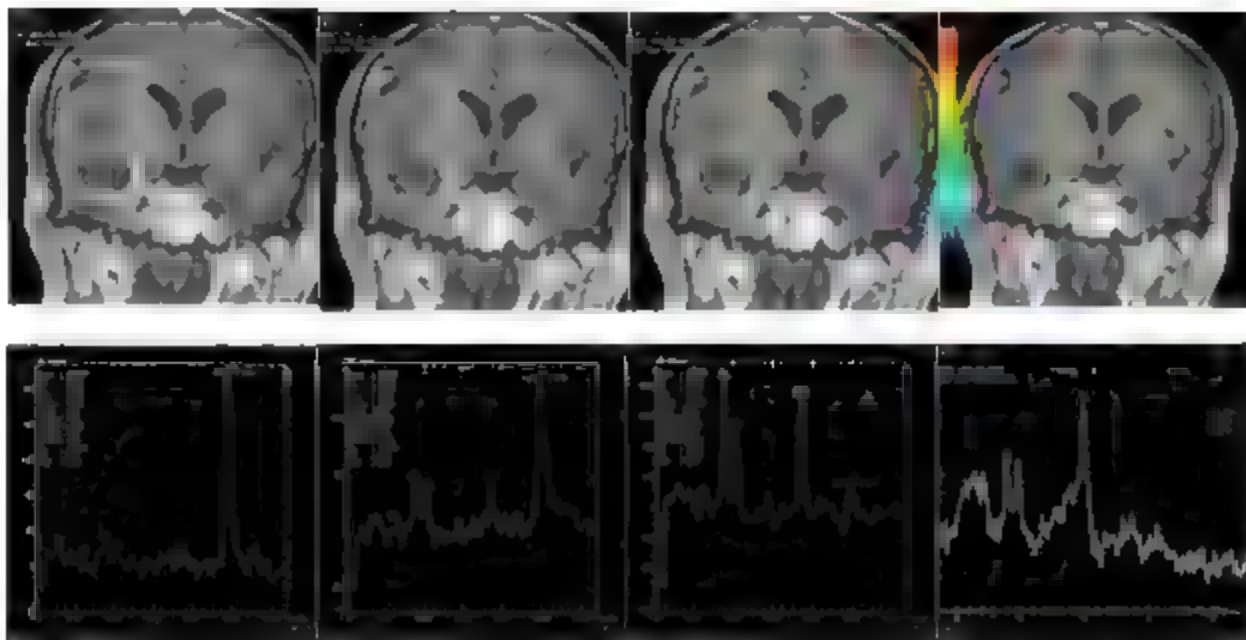






Multi-voxel allows comparison with normal tissue.

MRS of an abscess

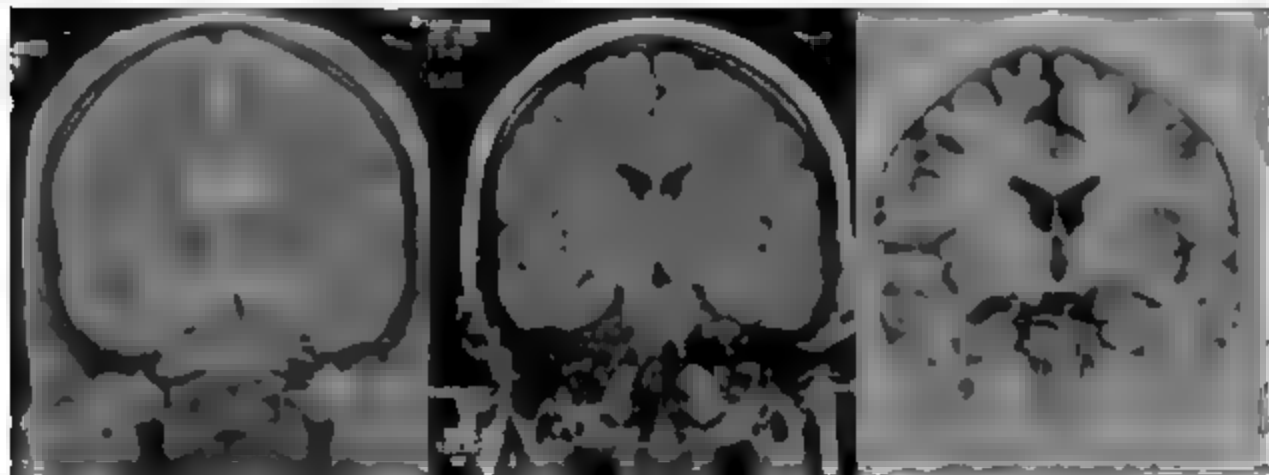


MRS

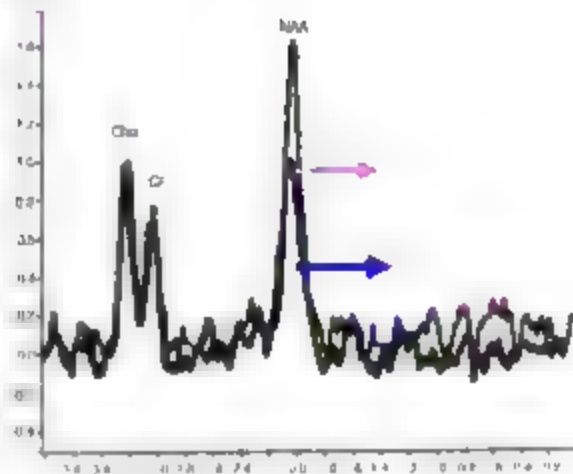
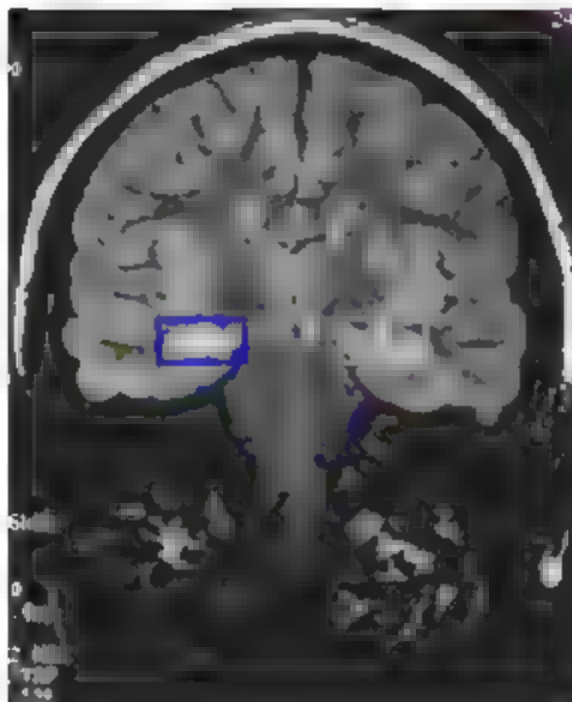
- Apart from Tumors, Necrosis and Infections

ARE THERE ANY OTHER APPLICATIONS FOR
MRS?

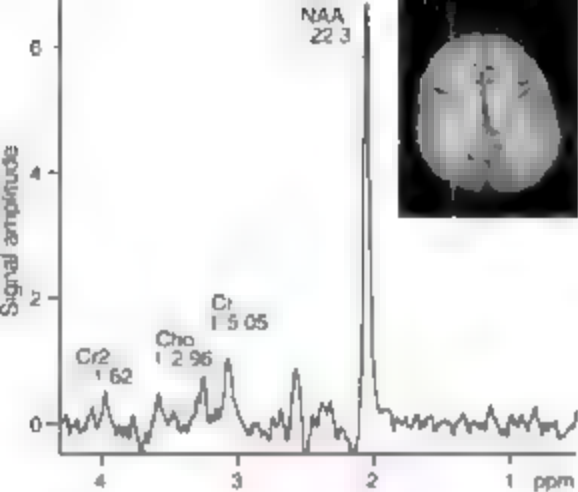
TLE



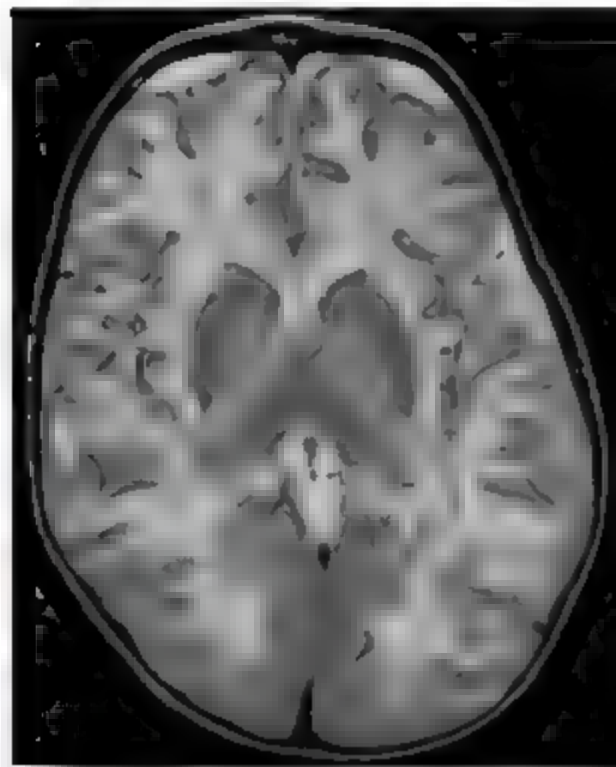
TLE



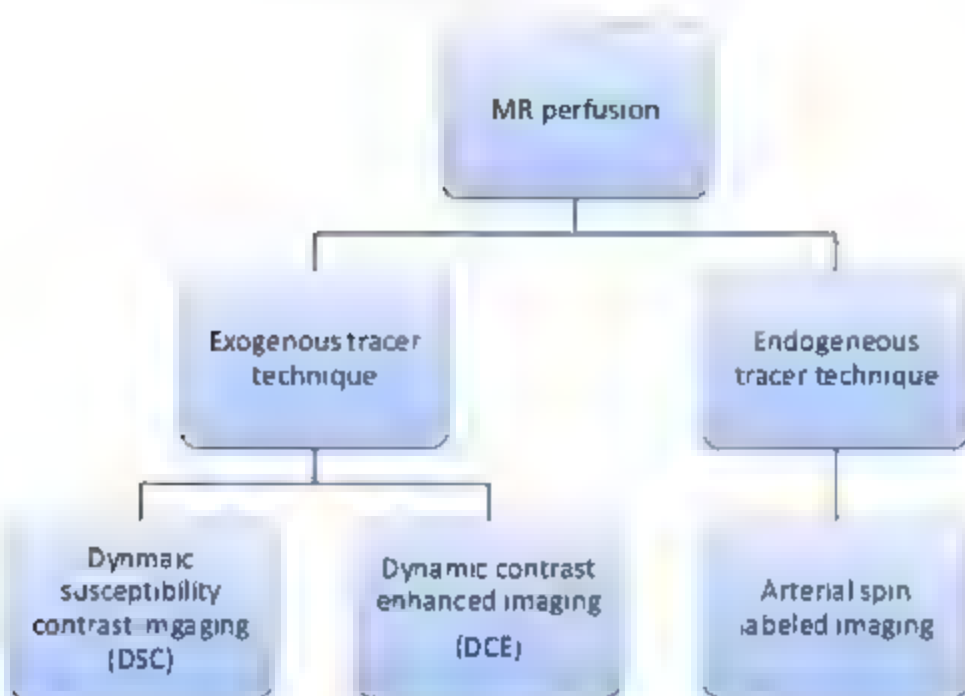
- ◆ Lateralization
 - ◆ Decrease NAA
 - ◆ Increased Choline (15%)

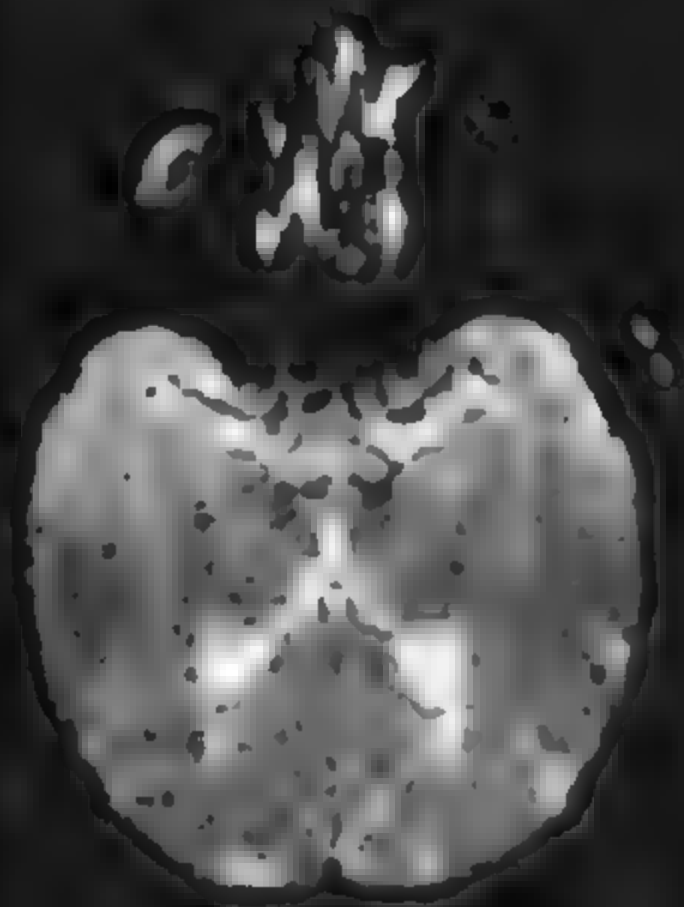


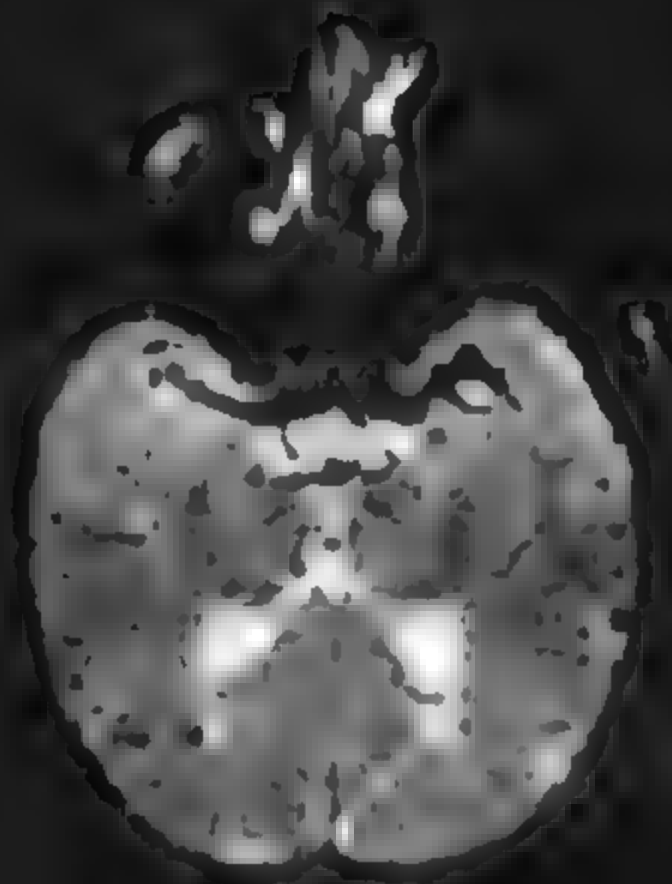
Canavan disease



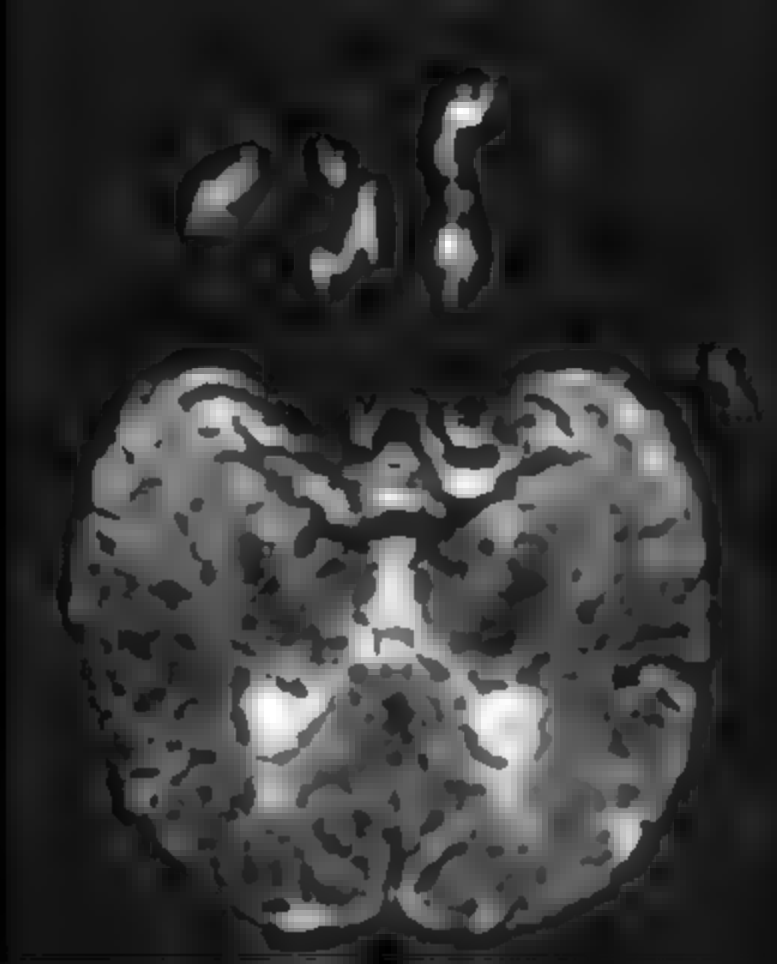
MR perfusion

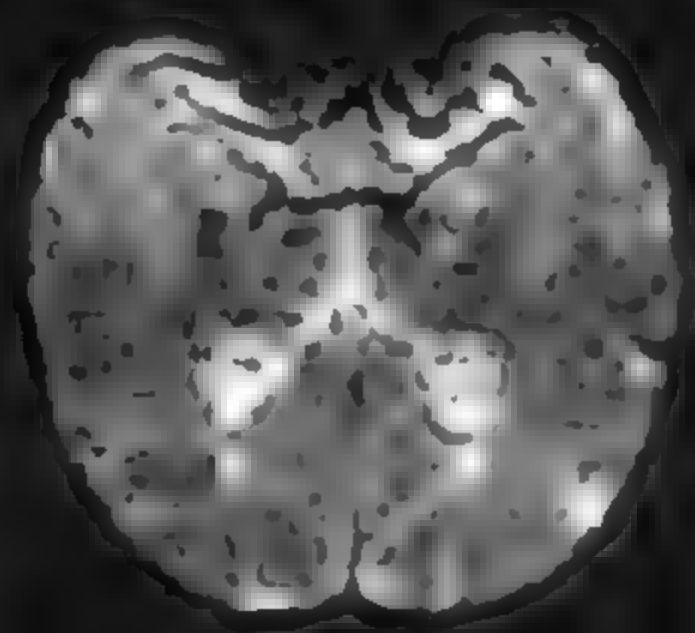








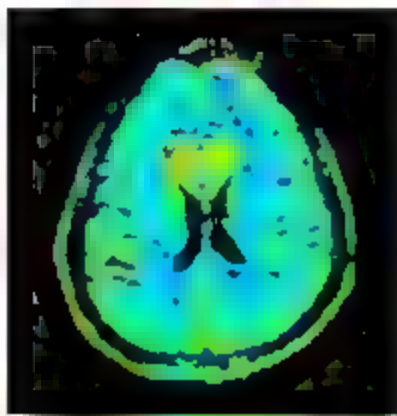




MR perfusion

CBV color map

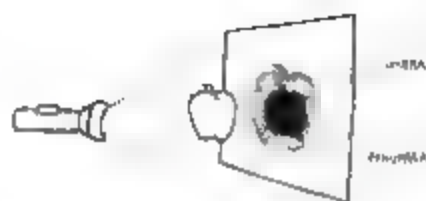
Time signal intensity curve



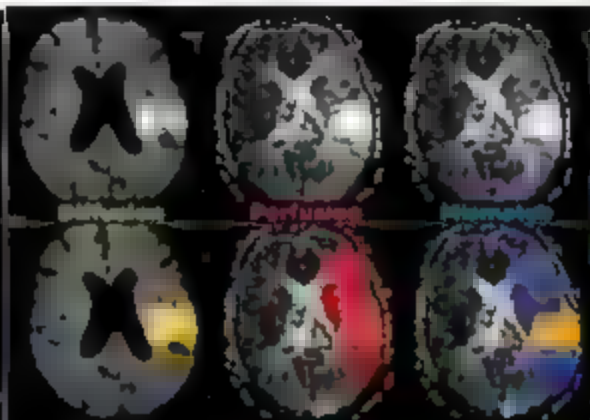
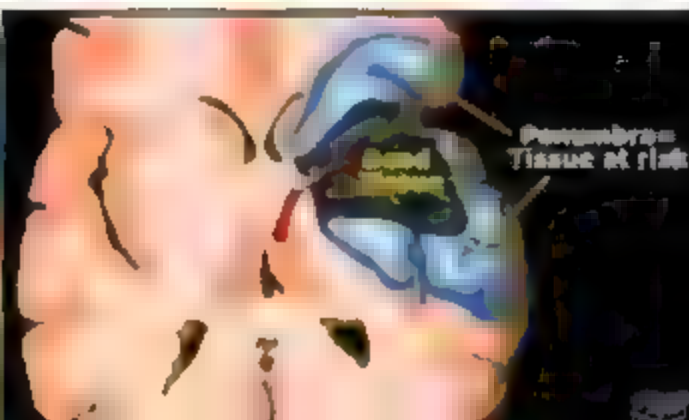
MR perfusion

<u>Variable</u>	<u>Definition</u>	<u>Measurement</u>
<u>Cerebral blood volume</u>	Volume of blood in a given region of brain tissue	milliliters per 100 g of brain tissue
<u>Cerebral blood flow</u>	Volume of blood per unit time passing through a given region of brain tissue	milliliter per minute per 100 g of brain tissue
<u>Mean transit time</u>	Average time it takes blood to pass through a given region of brain tissue	Seconds

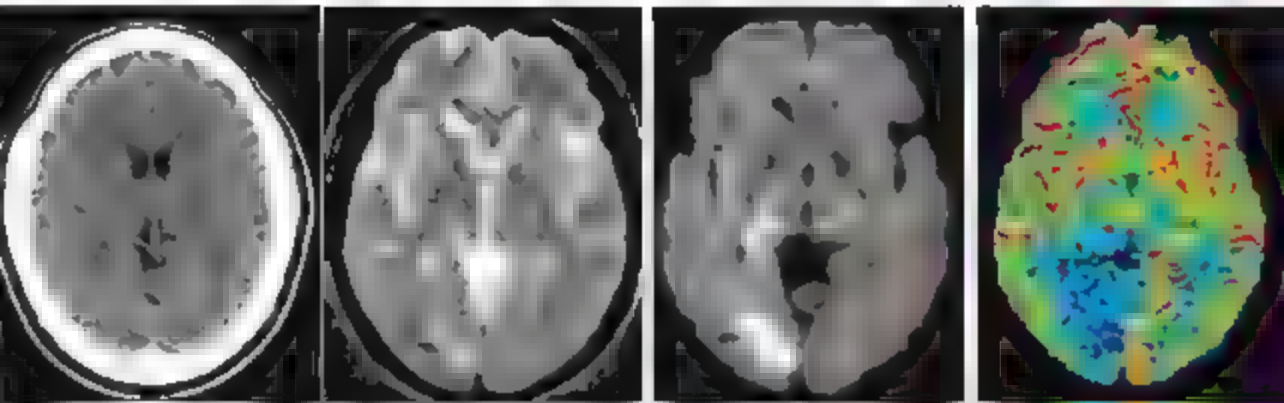
Stroke penumbra

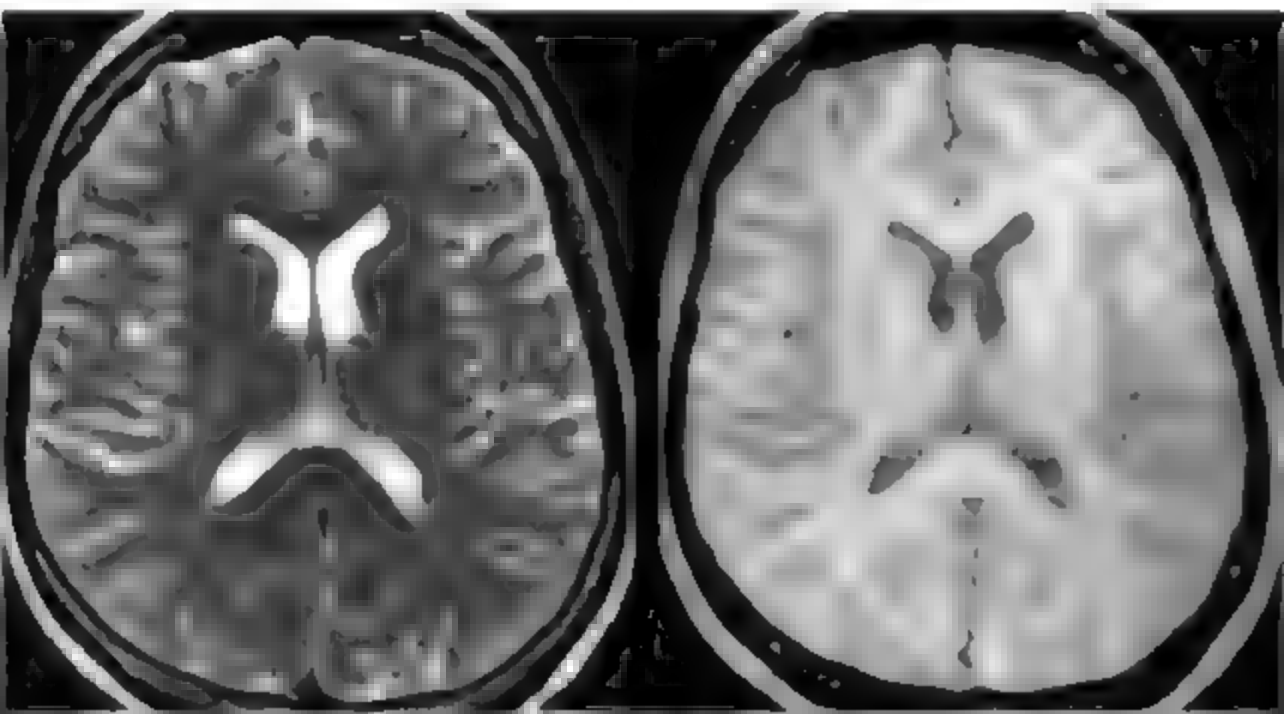


- Penumbra = perfusion / diffusion mismatch \rightarrow thrombolytic therapy

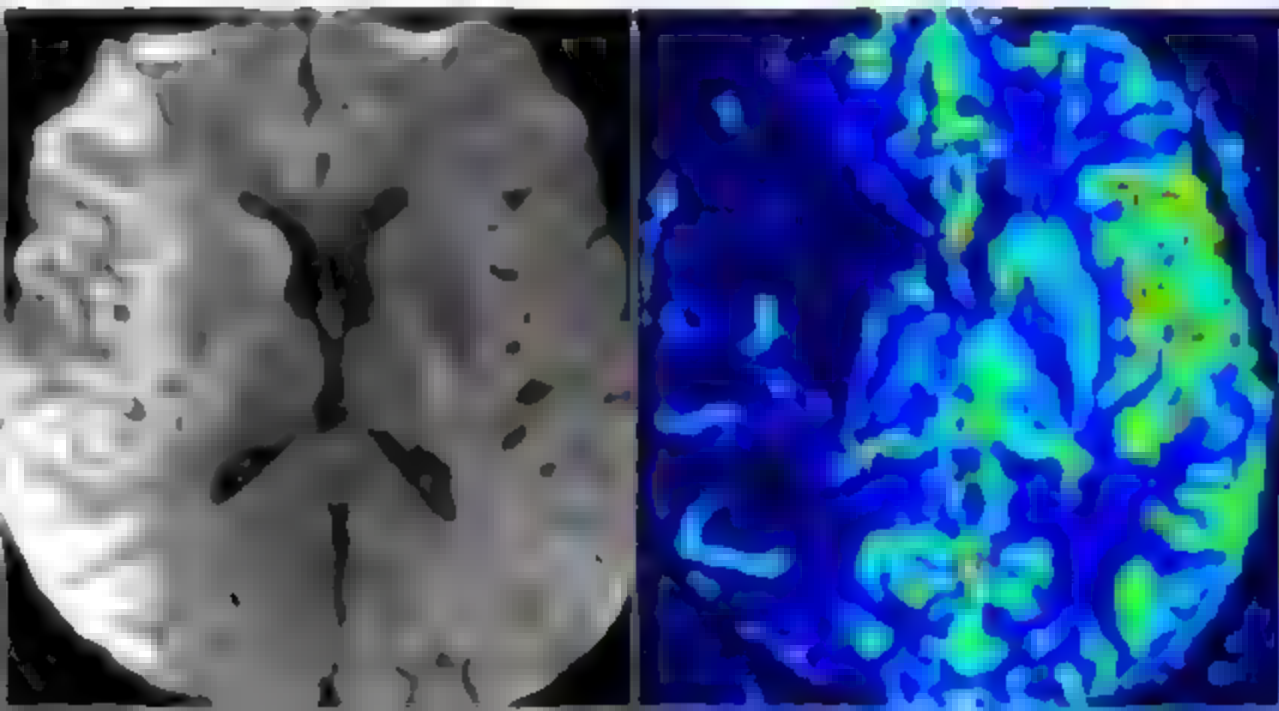


Diffusion/perfusion mismatch

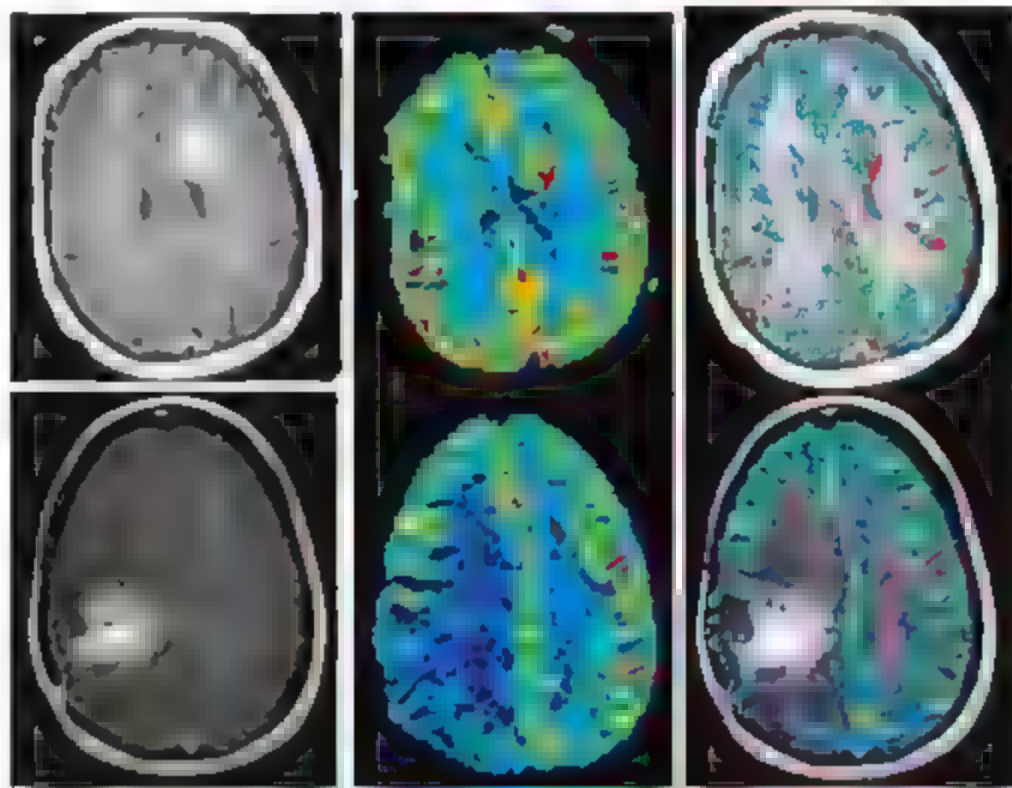




Diffusion/perfusion match



Post-radiation necrosis vs recurrent neoplasm



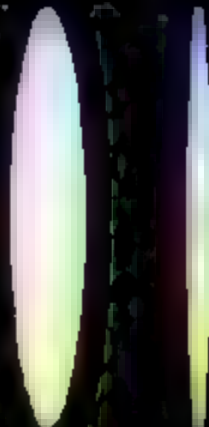
Diffusion tensor imaging

- MRI technique that uses anisotropic diffusion to estimate the axonal (white matter) organization of the brain

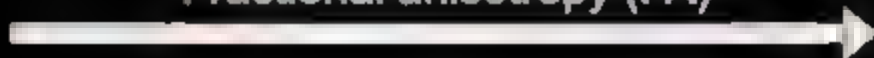
Isotropy

Low anisotropy

High anisotropy

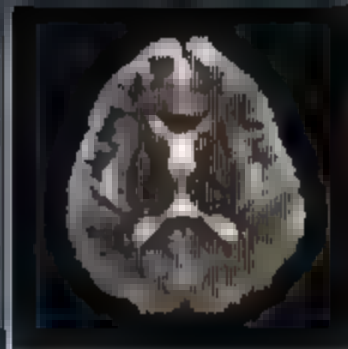


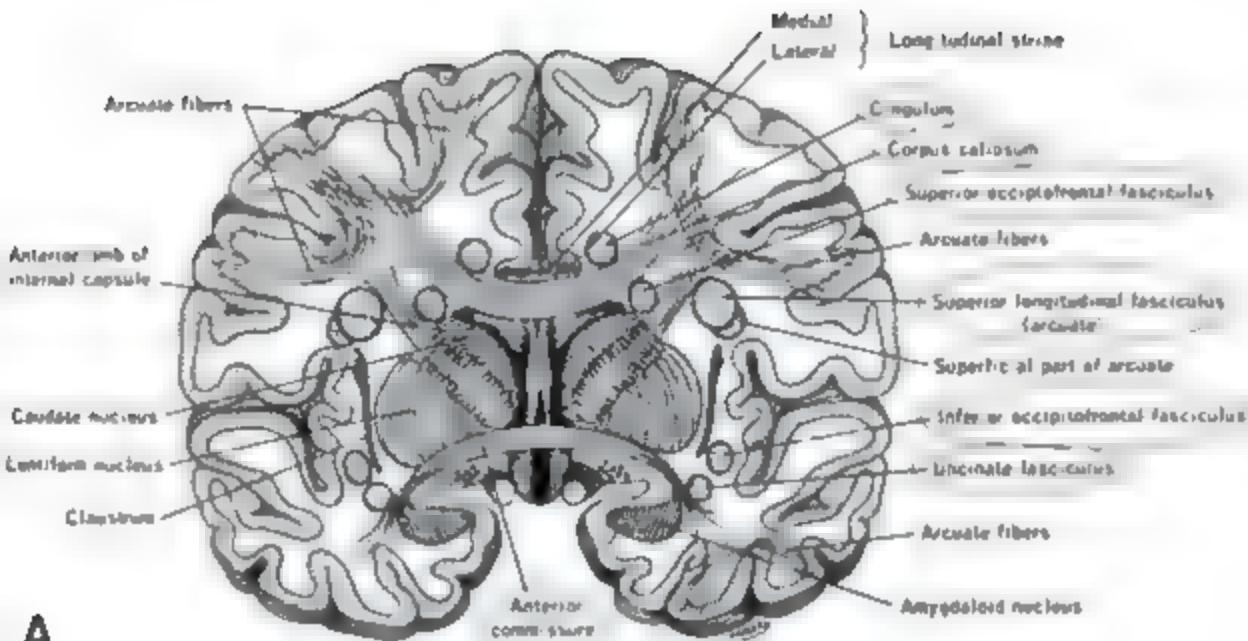
Fractional anisotropy (FA)

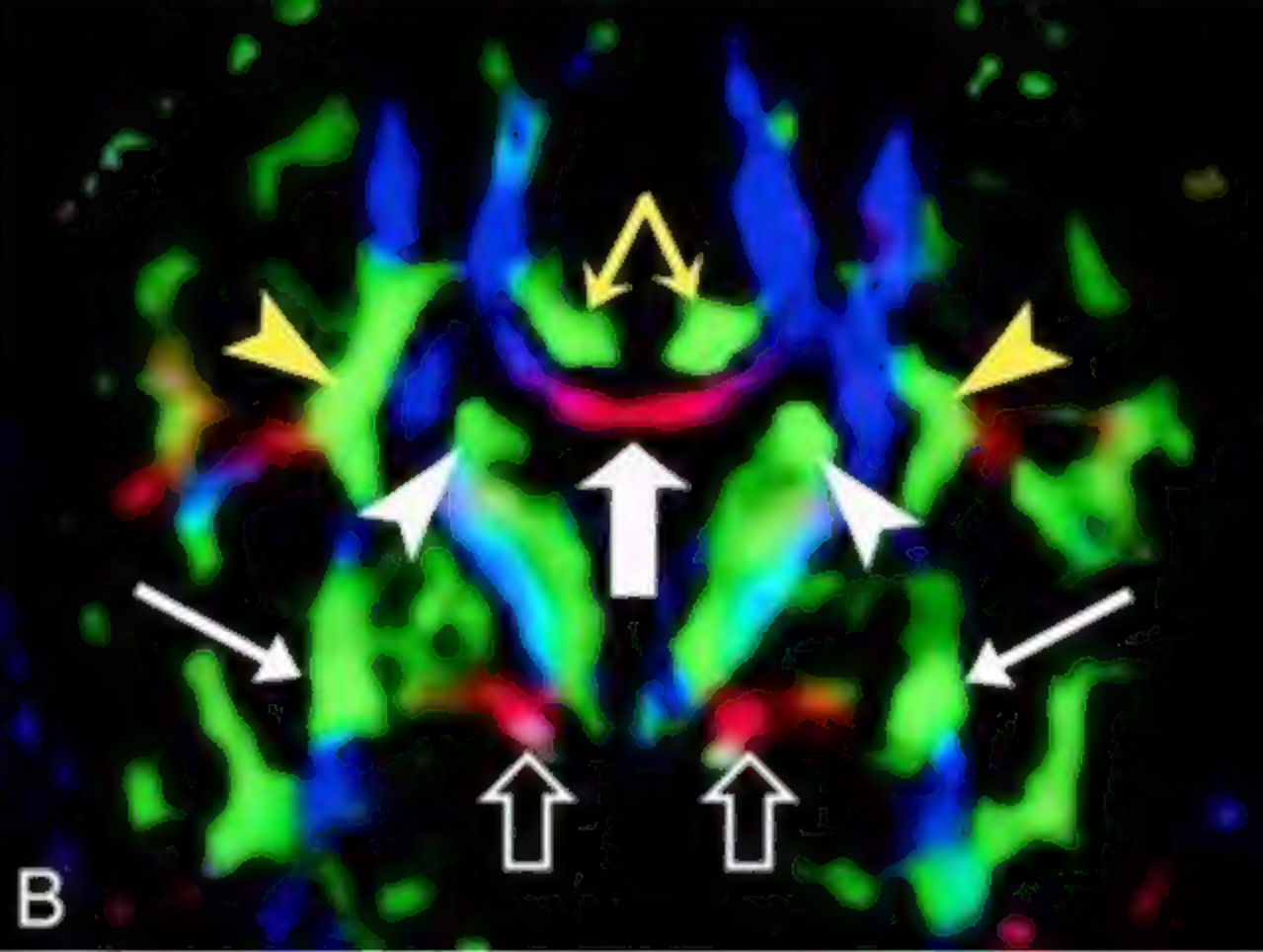




Ellipsoidal
visualization of
diffusion tensor
data







Fiber tractography (FT)

- is a 3D reconstruction technique to access neural tracts using data collected by DTI.

Color coding of fiber tractography

Red	Commissural fibers	Right → left hemisphere
Blue	Projection fibers	Cortex → subcortical grey matter
Green	Association fibers	Cortex → cortex

Projection fibers

Long projection fibers

Cortico-spinal

Cortico-bulbar

Cortico-pontine

Cortico-reticular

Short projection fibers

Thalamic radiation
(thalamo-cortical)

Anterior thalamic radiation

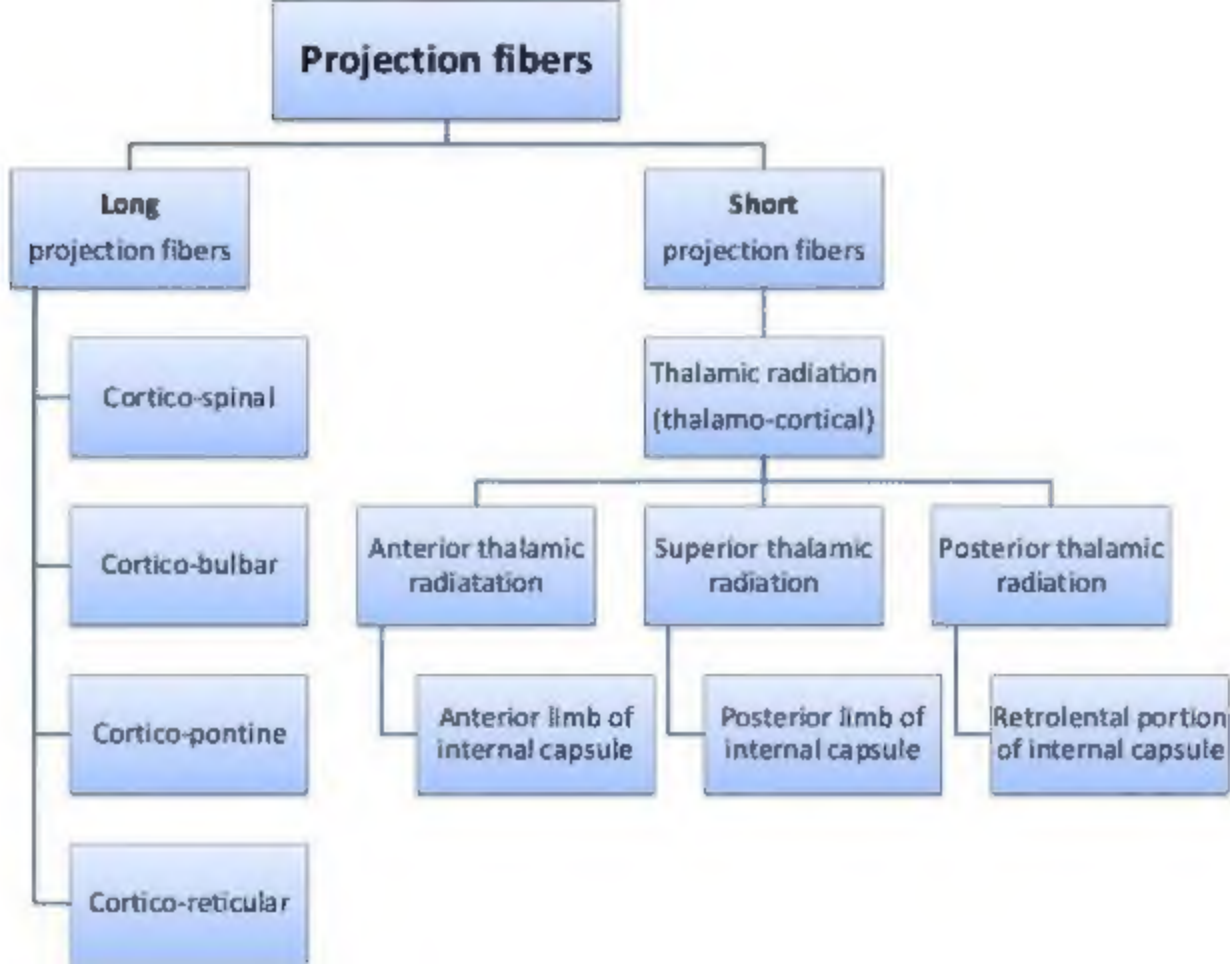
Anterior limb of
internal capsule

Superior thalamic radiation

Posterior limb of
internal capsule

Posterior thalamic radiation

Retrolental portion
of internal capsule



Association fibers

Long

(inter-lobar)

SLF

ILF

SFO

IFO

Cingulate

Uncinate

Fornix

Short

Intra-lobar (U shaped)